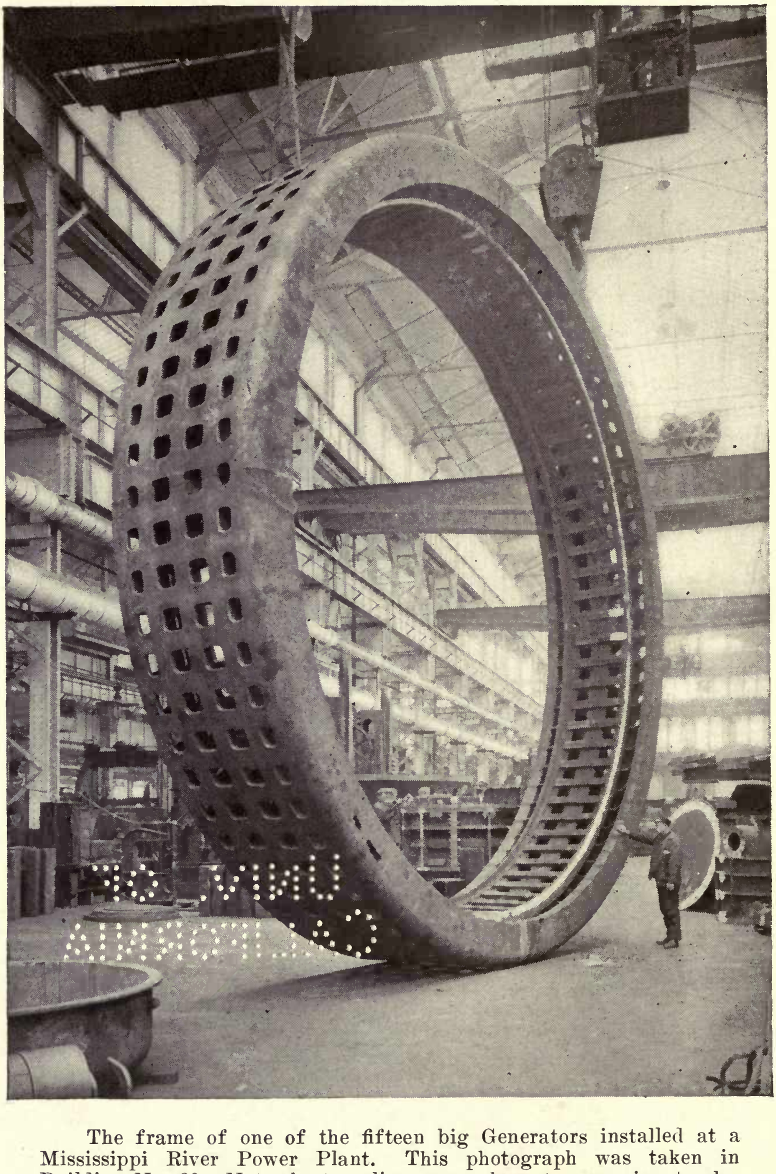


The frame of one of the fifteen big Generators installed at a Mississippi River Power Plant. This photograph was taken in Building No. 60. Note the traveling cranes have two running tracks, one above the other.

Romance of a Great Factory

By

CHARLES M. RIPLEY, E. E.

Author of

"Life In A Large Manufacturing Plant"

With Introduction by

DR. CHARLES P. STEINMETZ

The Gazette Press
Schenectady, N. Y.

DEDICATION

SINCE THE FOLLOWING CHAPTERS WERE ALL DICTATED TO HER, THE AUTHOR DEDICATES THIS BOOK TO HIS "ELECTRICAL SECRETARY." SHE IS MOST AMIABLE, PUNCTUAL, FAITHFUL AND PAINSTAKING; SHE IS A GOOD LISTENER AND AT TIMES HAS EVEN BEEN INSPIRING! AND, AS SHOWN IN CHAPTER VIII SHE IS EVEN POSSESSED OF A CONSIDERABLE AMOUNT OF DARING.

PREFACE

The romantic or human interest side of present day industry is a reality, though unfortunately many can see only the grimy and uninteresting routine of production.

There are curious, spectacular and sentimental aspects to the life, achievements, work and play of those who are employed in a big industrial plant.

The writer desired to express his appreciation of some of the sights and sounds of the shop and of the men—his fellow employees of the General Electric Company at Schenectady, N. Y.

So, with no effort to produce "literature," these stories were hastily dictated while still under the spell of the spectacular and awe-inspiring scenes witnessed on various trips thru our great factory employing nearly twenty-five thousand men.

It is possible that these impulsive attempts to faithfully present glimpses of factory life and romance, will serve a useful purpose; and perhaps in the future may induce some master to undertake the preparation of an adequate record for future generations.

THE AUTHOR.

AUTHOR'S NOTE

For each copy of this book sold, a donation of 10 cents will be made to the treasury of the Schenectady G. E. Mutual Benefit Association. This Association provides its members Health, Accident & Life Insurance for an average of approximately 7 cents per week.

CONTENTS

CONTENTS

INTRODUCTION

BY

DR. CHARLES P. STEINMETZ

CHIEF CONSULTING ENGINEER, GENERAL ELECTRIC COMPANY

"We are living in an unromantic age. Before the shriek of the locomotive the wood nymphs have fled, and the factory whistle has driven away the romance of the old times. Art and poetry cannot flourish in our cold engineering age."

Thus says the professor of literature dissecting the master works of by-gone ages from Homer to Goethe, and tells us what literary art is.

Why do our literary men of today write "best sellers"—books whose only redeeming feature is that they are forgotten as quickly as sold. They fail to see the wonders of our day, the greatest in the world's history; they find nothing worthy of their literary skill, in our "cold engineering age"! But, over and again, they repeat the story of erotic sentimentalism, running up and down the scale from hysteria to pathological degeneration. Hopelessly out of touch with the world of today, they see nothing in it except sensual erotics of the more hysterical types; and it is characteristic that even in Faust, the world's greatest drama, our literary generation dwells chiefly on the merely incidental love episode of Marguerite.

When Homer wrote the Iliad and the Odyssey he told us of the adventures of *his* age; the conquest of Troy; the wanderings of the navigator through the terrors of the ocean at the dawn of history. Three thousand years later in his autobiography, Faust, Goethe tells us the adventures and aspirations of *his* age: from the youthful efforts to conceive the absolute—groping after the ideal of the true and beautiful—up to the satisfaction of sedate manhood, helping mankind to conquer Nature, and make the earth a better place in which to live.

The great writers of the past wrote of the age in which they lived, but the writers of today are out of touch with the Twentieth Century. There are a few exceptions; but rarely only does a Mark Twain discover romance in a "Tom Sawyer" or a "Huckleberry Finn"; seldom does a Jack London give us a "Buck" or a "White Fang"; there has been but one poet of the engineer—Kipling—with his "Day's Work" and "McAndrew's Hymn."

Those of us who have the education, leisure and inclination, can put ourselves back into the days of by-gone ages—enjoy their literary master-works, and travel with Homer through the terrors of the Mediterranean; but to most of us the only known world is the world of today—of the steam-ship and the railway train, the factory and mill, the electric light, telegraph and motor.

Is there no poetry in this world of ours? Do we really lack romance in this scientific and engineering Twentieth Century? Or is it not rather that the ignorance of the average literary man disables him to see the romance of our age!

There is more poetry, more romance in the advances which we have seen in our life-time than ever Homer described.

We navigate not only the surface of the Mediterranean, but its very depths by submarine. We fly to the higher altitudes of the skies by aeroplane. We fling the human voice over thousands of miles across continents and oceans by telephone. Still unborn generations will hear the living voices of our musicians—bequeathed to them by the phonograph. Our great-great-grandchildren will see in action our prominent men of today—recorded and everlastingly perpetuated by the cinematoscope—that new historian of these great times.

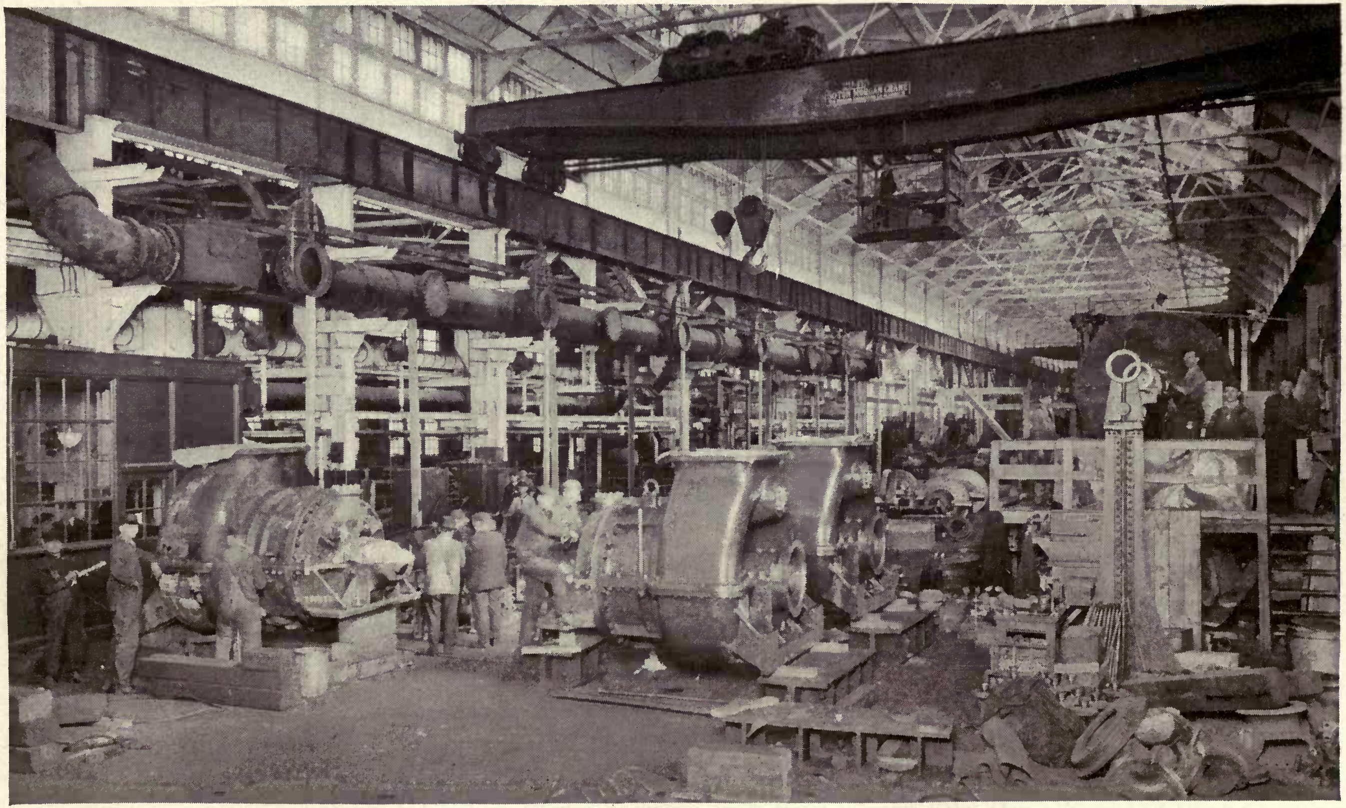
There is romance in the life of the vigilant mariner who listens to the wireless message from distant shores. There is tragedy in the fate of the giant battle cruiser, military engineering's greatest advance; and with more effective power than all the war engines of former ages. Manned by thousands of men, guarded by heavy steel walls, running through the storm-tossed ocean with the speed of the hurricane, she goes to meet the enemy in the Nation's defense; and six minutes afterward her shattered hulk sinks beneath the waves.

There is romance in the mighty spinning top, the steam turbine fed by the stored sun-light of prehistoric ages—ages when ferns were giant trees, and our ancestors were crawling things in the slime on the shores of the lagoon—not very long ago, as time is counted in the universe. Turning at a speed which would carry it across the continent in a few hours were it not imprisoned in the power plant, some single turbines furnish mankind with electricity equalling the power of sixty thousand horses. They turn night into day and propel the electric train with the speed of the gale. They actuate mines and factories and make possible wonderful materials unknown to former generations.

In the modern factory there is far more romance and poetry than there has ever been in the history of the past; but we must be living with it to see and understand it. That is we must be living with the men of our Century, and not sheltered in the dust of past ages.

Therefore, I welcome this book, for the engineer-author lives with us—is a member of our organization. We are doing the world's work of today. He understands it, and sees the poetry in it. He describes the adventures of the thousands of us who have gathered together here in an organization mightier than any age has seen; have contributed to the conquest of Nature; and by our work have helped to make the world a better place in which to live.

CHARLES P. STEINMETZ.



View of Building No. 49 showing three of the turbine ship propelling outfits being painted and receiving their final adjustments. Note the large steam pipe used for testing purposes. John Engle is shown operating one of the 19 overhead electric cranes in this building. Engle has had 17 years experience as a crane operator with the General Electric Company.

CHAPTER I

THE GREAT INDUSTRIAL ORCHESTRA

I happened to walk through building number 49 the other day at 12:27 o'clock. The only sound was the low conversation of a few men chatting together as the end of the dinner drew near.

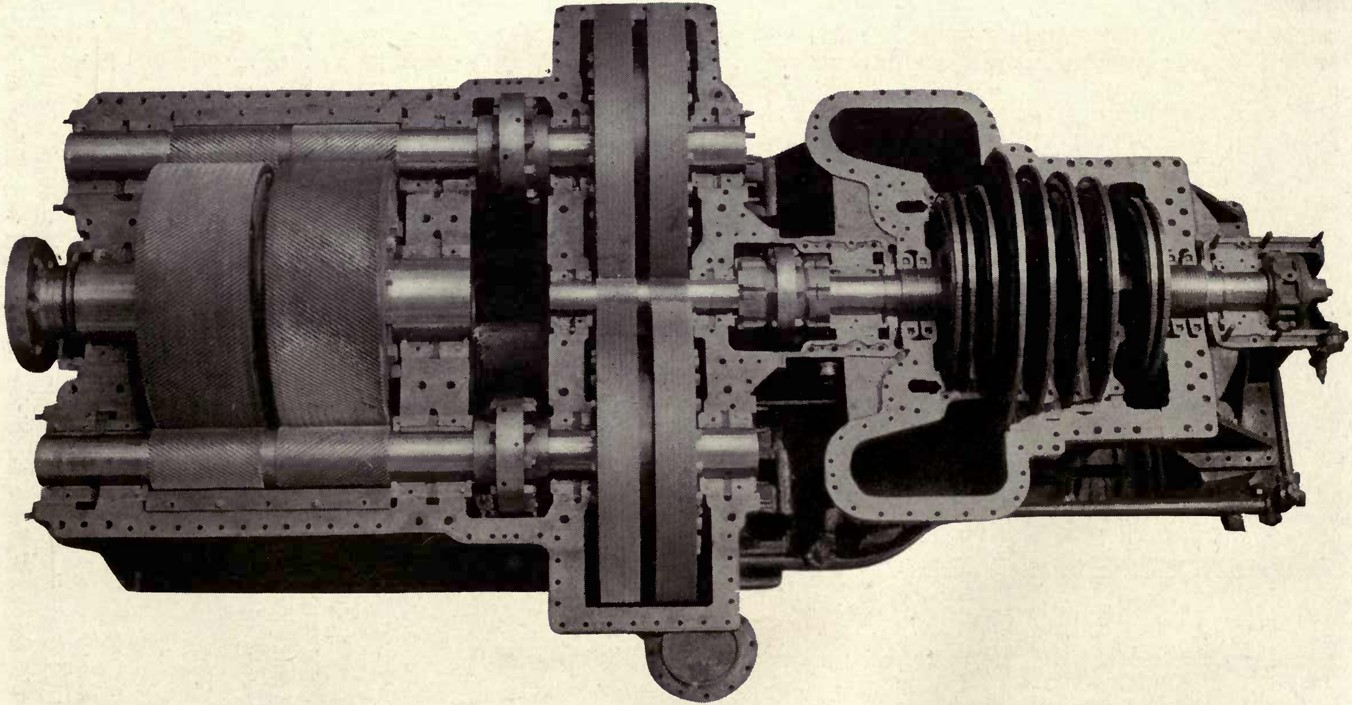
Walking down the aisle of the building—1200 feet long—I was viewing the giant machines which towered high above my head on either side, when suddenly the roar of the 12:30 whistle interrupted my thoughts.

Before the whistle had stopped blowing, I saw one man neatly fold up his newspaper and put it in his coat pocket; and scarcely had the sound of the whistle died down than there arose sharp and clear, the shrill whine of a motor driving one of the smaller machine tools. But it was only for an instant that the high soprano of this motor filled the building, for almost immediately it was followed by a second machine—one whose motor sung a tenor note. And I had not taken 20 steps after the blowing of the whistle when the deep rumbling grunt of a boring mill took up the bass. In less time than it takes to describe it, lathes, drill presses, cranes and hand tools all joined together singing their respective parts, and I was surrounded by a great industrial orchestra—the building reverberating to the indescribable song of American industry.

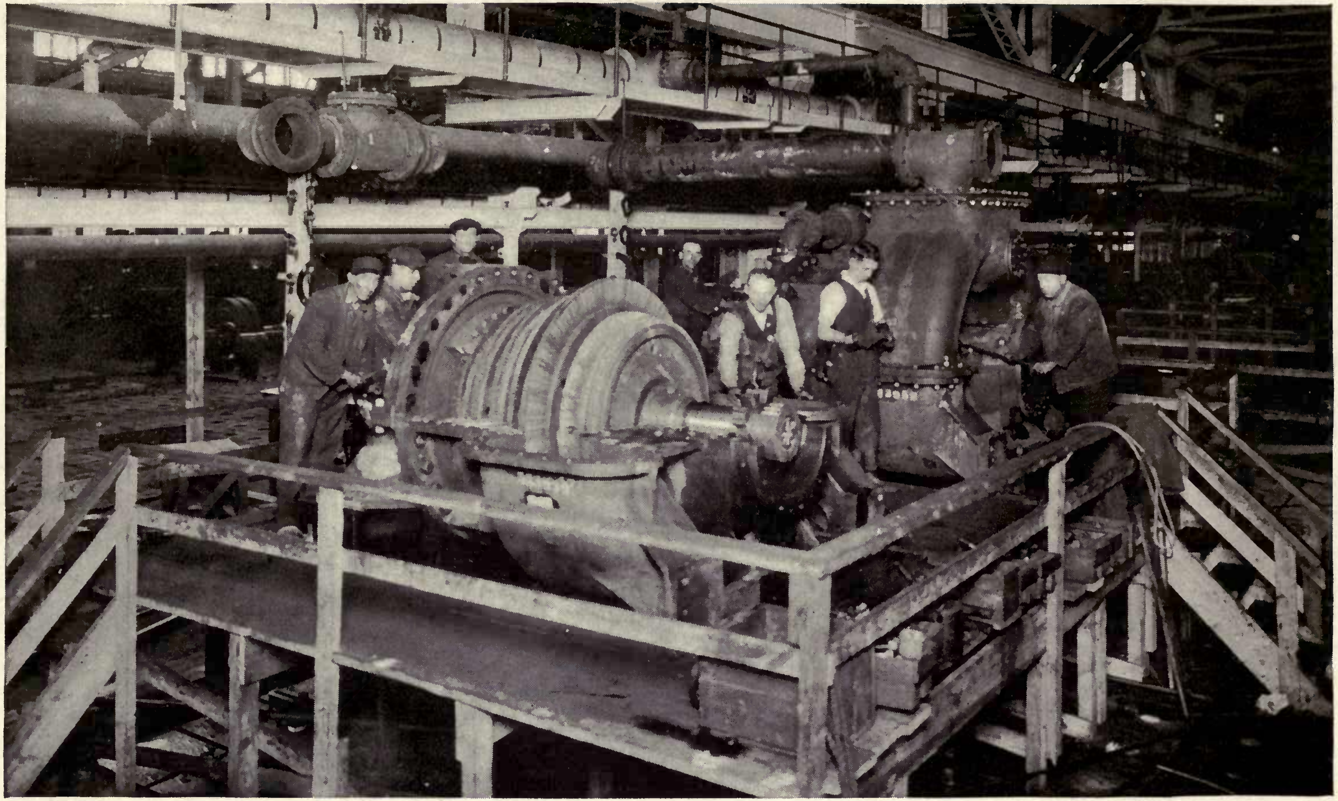
A step more, and the sharp staccato strokes of some pneumatic tools dominated the song; and then an overhead electric crane swooped down and gently deposited 17 tons of cast iron at my feet.

STEEL FOR OUR SHIPS.

All around me, reverberating from the high ceilings and resounding from the white-washed walls—was the voice of steel as it tortured steel—fabricating the turbines which will drive America's ships. These turbines will propel our ships not only



Unusual view of the type of geared turbine used for propelling the Merchantman " Schenectady " launched at Hog Island in March 1919. The bucket wheels are in the right, the intermediate gears in the centre, and the low speed gears on the left. The propeller shaft is attached to the flange at the extreme left. These gears reduce the speed from 3,100 on the turbine shaft, down to about 90 rev. per. min.



Testing steam turbines for Uncle Sam's new cargo ships. One of the turbines has the top casing removed showing the wheels with the blades set in the rim. Hundreds of compact ship propelling outfits were built in record time in Building No. 49.

through the war-infested waters of the present, but for years to come they will drive them through peaceful waters as well — carrying the commerce of a trading world. For when this war is over, American goods will be sent by American ships to every quarter of the globe.

And it is in building number 49 that you will see completed each day an entire ship-propelling outfit for our new vessels which are destined to do this double duty in promoting the welfare of our nation.

Thus the great song which I heard was both a promise and a proclamation; a promise to our men overseas that we are answering their call for the transportation of food and supplies; and a proclamation to all the world that we will be independent of others in shipping our manufactured products to the far corners of the earth.

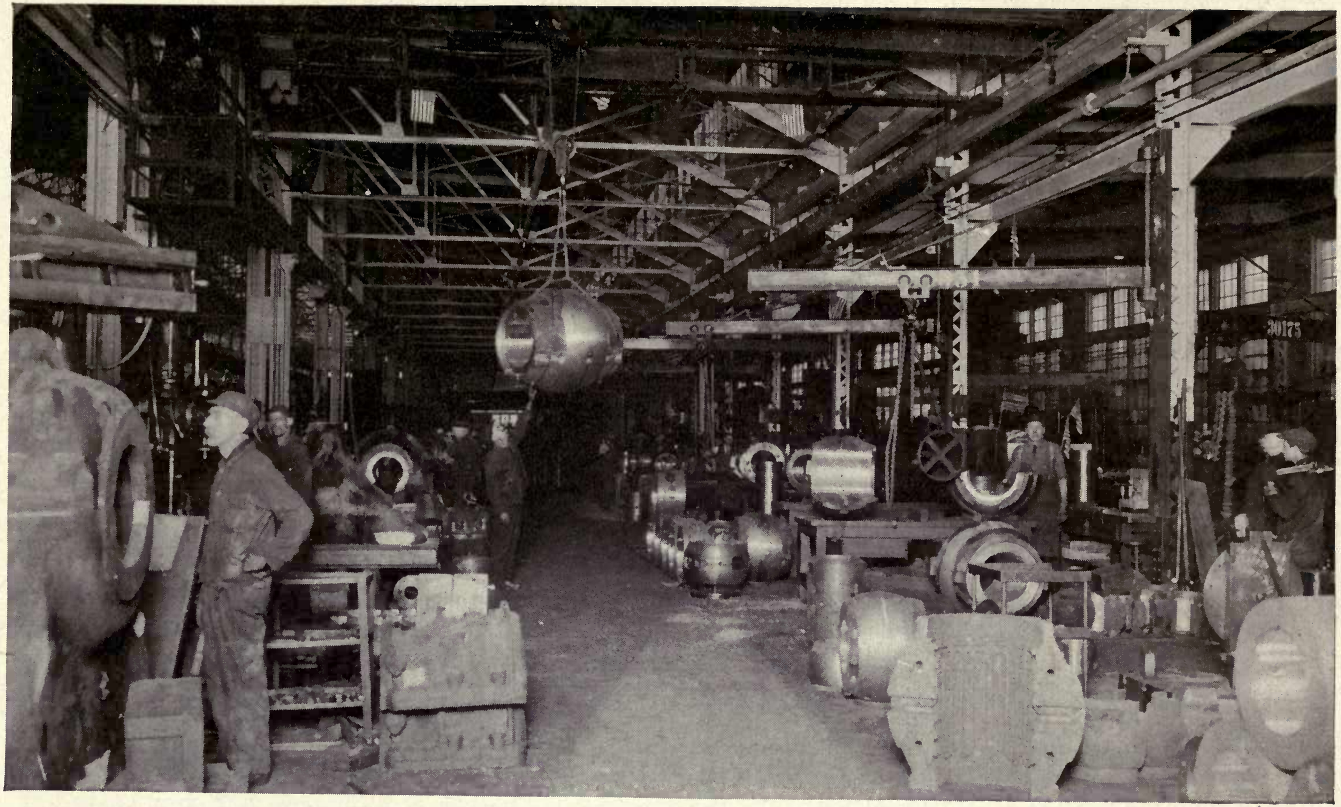
But there are more than mere sounds to be described in this great building. Here 550 men—expert mechanics and machinists—take castings that weigh from 17 to 28 tons, machine them, scrape them and adjust them to within one-thousandth of an inch.

It is a picked crew who works in this building—all selected for the rush work necessary to do two things at one time—not only to turn out the finished product, but also to convert this building from a foundry into a machine shop.

THE MAGIC TRANSFORMATION.

For it is almost inconceivable that this building, now a full-fledged machine shop on a grand scale, was only last April a foundry running full blast. The great feat of converting this from a peaceful foundry to a more or less war-like machine shop in four or five months is similar to re-building a bridge while traffic is going over it, or it can even be compared to the construction of the new Grand Central depot which was carried on without interrupting the service of millions of passengers.

Think of the work which it meant, architectural changes to the building, the installation of the heating system, the removal of the foundry equipment, the purchase and installation of new machine tools to secure which the country was scoured from Milwaukee to Philadelphia. Foundations were built while



Making the bearings of turbine ship propelling outfits shine like silver. This picture was taken in Building No. 49. Note the water-cooled bearing on the right of the picture. Cold water is circulated through these pipes to prevent a hot-box.

the wires were kept hot telegraphing to trace the shipments of the machinery.

Some tools came from building number 60, some from Erie, some were purchased new, some secondhand. For a period of a few weeks this building was a foundry at one end and a machine shop in the other, and the turbine men were crowding the foundry men on the one hand, asking for more space, and were installing the new machine tools as fast as they came in from all sections of the country.

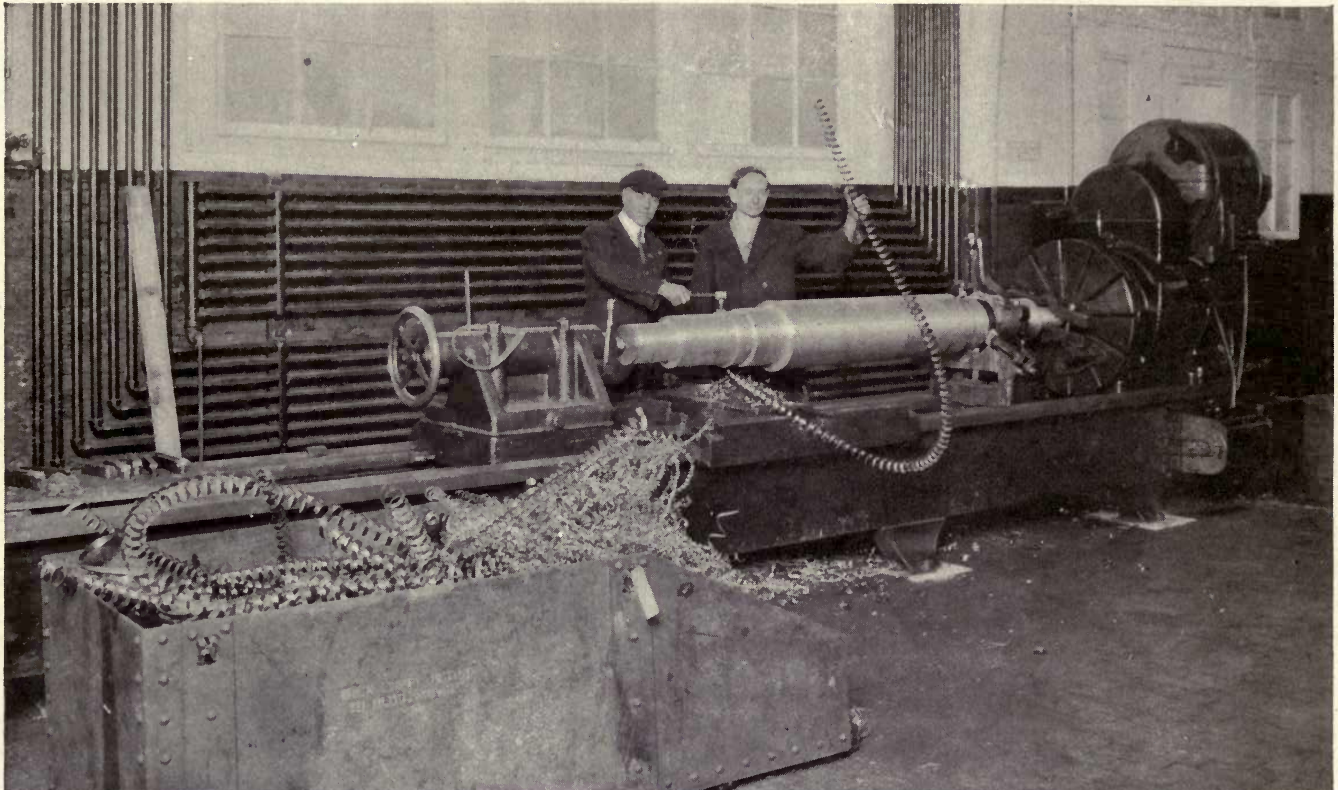
FOREMAN SAYS HARMONY DID IT.

Charles Palmer, general foreman, says the change-over was only possible because of the harmony that existed all along the line, every man with his shoulder to the wheel. This is the kind of team play and co-operation that makes history and breaks records.

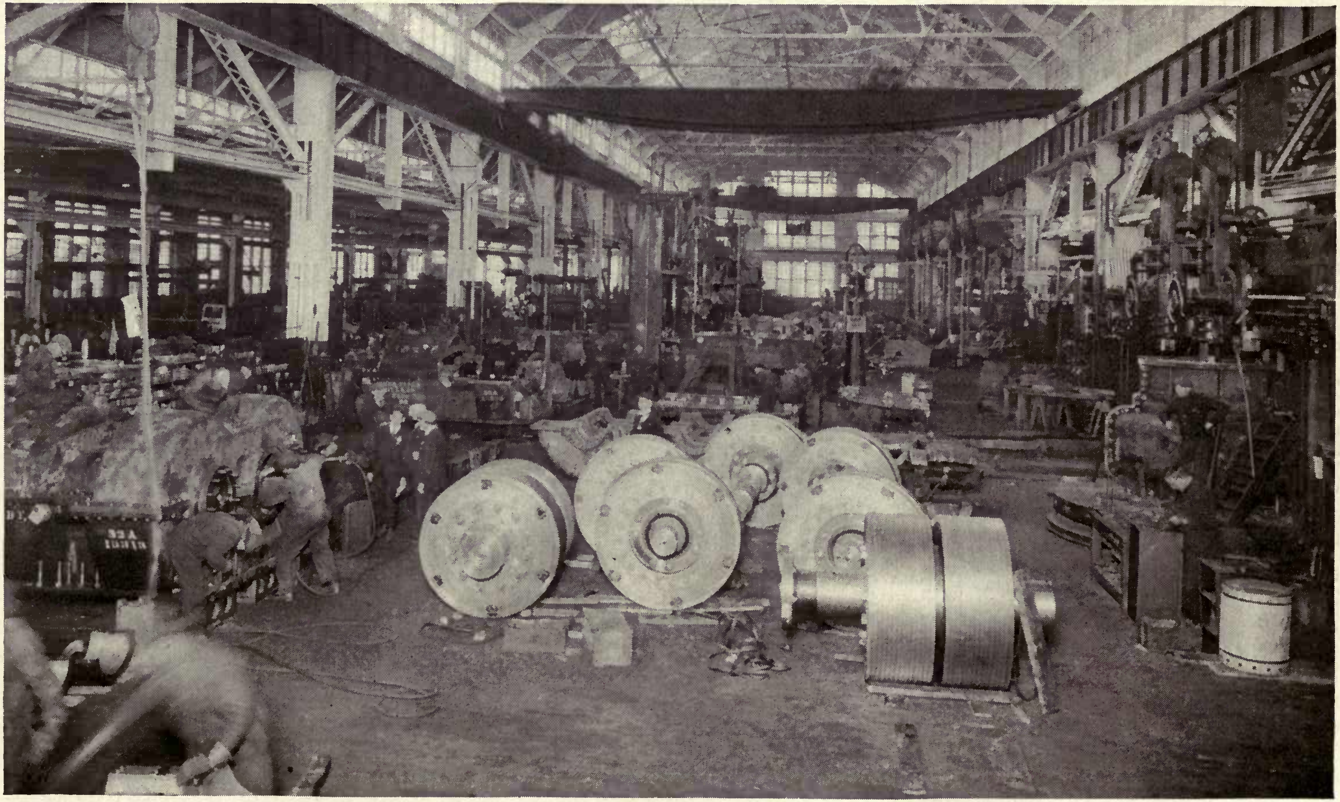
And now it is a machine shop from end to end—longer than building number 60 and 300 feet wide—it is a panorama to gladden the eye of any one who thrills at the sight of a huge busy industrial plant.

Where the men are working on steel, there you see blue chips; where the men are working on babbit metal for bearings, there they shine like silver; where they are working on cast iron, there you see the final cut and the scraping which brings it to dimensions accurate within one-thousandth of an inch, and to a finish which resembles a metallic mirror. (And everywhere, from one end of this lofty hall to the other, you see machines running, spinning; all of them working) turning out "production." I was almost inclined to make a note of the number of idle machines to be found in that great building, but the general impression was that 95 per cent were in full operation and the men are proud of the fact.

Here it is that you touch elbows with men who are second to none in their respective trades. John Engle has operated a 50-ton crane for 17 years in the General Electric Company. Joseph McClusky boasts that all of his chips are blue—showing the speed with which he turns down the shafts for Uncle Sam's ship-propelling outfits. He is not content with a straw color — his conscience hurts him unless he has his iron box full of blue chips,

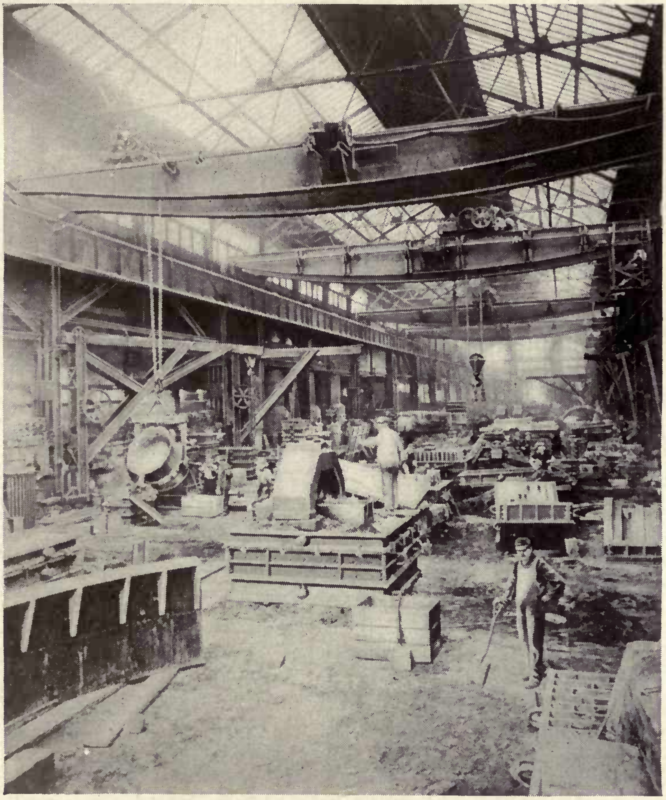


On the left is E. L. Allen in charge of the maintenance of machine tools in Building No. 49. He is consulting with "Bluechip" McCluskey who is turning one of the shafts for Uncle Sam's ship propelling turbines.



View in Building No. 49 showing rush work on the geared turbine ship propelling outfits. Six months before this picture was taken, the building was a foundry running full blast.

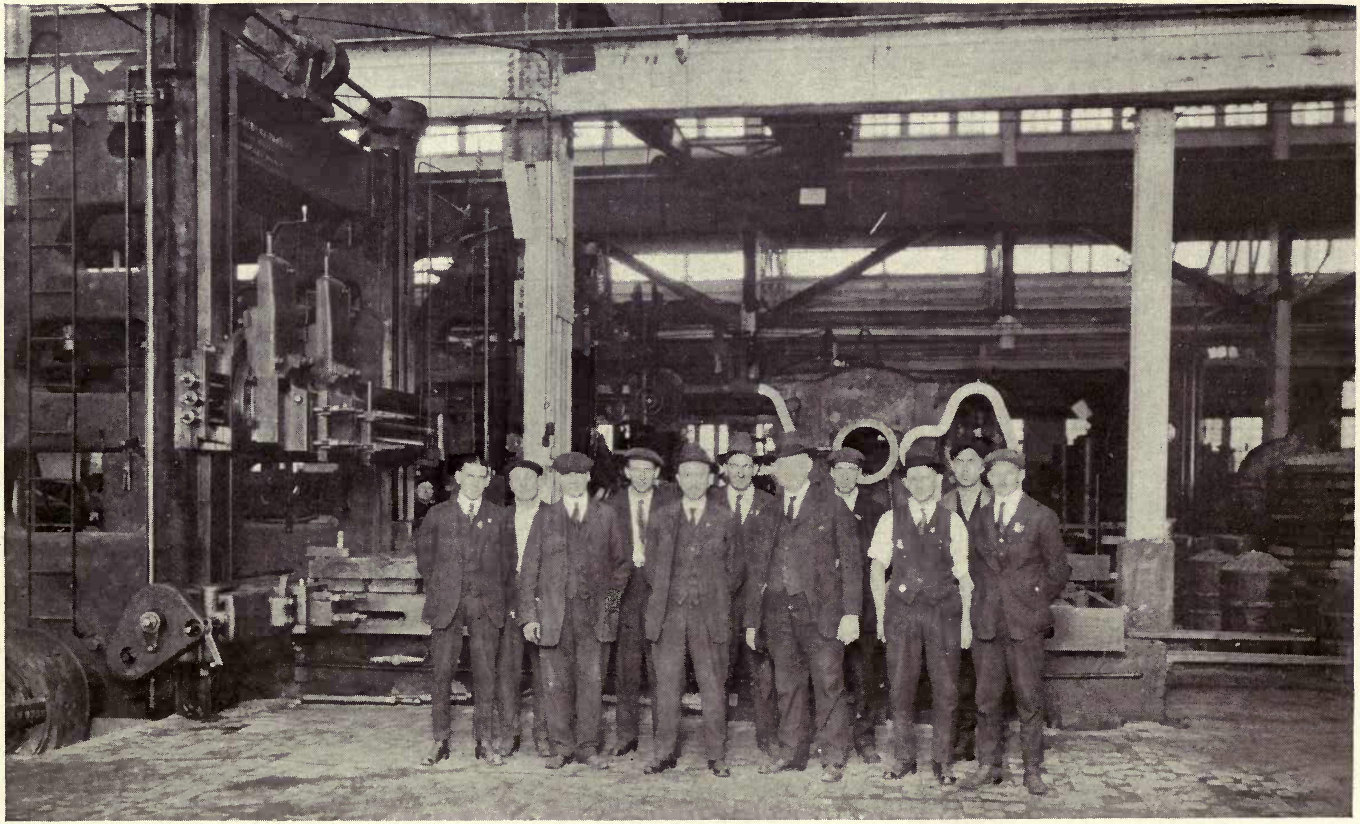
some of them 20 feet long. And E. L. Allen in charge of the repair and maintenance division is proud to say that there has been no loss of production due to break downs because he has kept the machinery in A-1 shape.



Picture of Building No. 49 taken from the same position as picture on the opposite page. This is the way Building No. 49 looked as a Foundry in the Spring. The opposite picture was taken in the Winter, and shows the magic transformation from Foundry to Machine Shop.

BEARINGS LIKE SILVER.

Benjamin S. Hesner, foreman of the bearing department, is the man who gets the credit for the fact that Uncle Sam's new merchant ships do not have a 'hot box.' He knows how fast babbitt



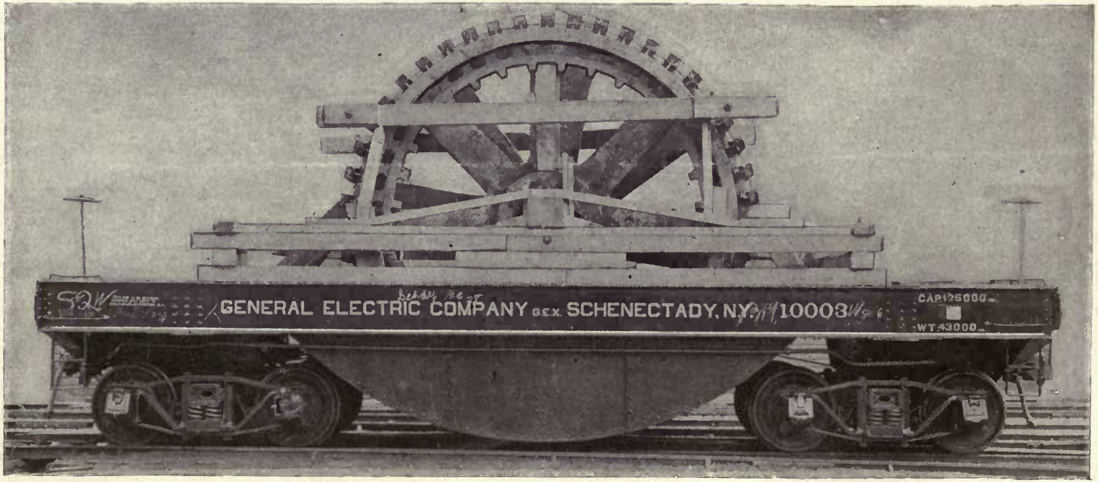
''High Pressure'' Palmer and his wide awake organization in Building No. 49. Not only did they transform the building from a foundry into a machine shop in one Summer, but by winter time they were turning out twenty-nine ship-propelling turbine sets every month. From left to right: Ernest Johnson, George Steiner, Frank McGill, George Clark, Benjamin Hessner, Orville Knickerbocker, Charles Palmer, General Foreman, William Leedon, Joseph Greely, William Cooney, Phillip McGarr.

metal shrinks compared with cast iron and explains to me how coils of pipe filled with cold water, are buried, invisible, inside of the babbitt metal to keep the bearings cool as the vessels ploy through the ocean at top-most speed. He takes pride in pointing out 25 jib crane hoists in his section, which do most of the lifting necessary for the heavy bearings.

Orville Knickerbocker, in charge of the machine work, boasts of one of the largest planers in the state of New York. He is in charge of the horizontal boring mills, machine tools apparently three times as high as your head, and served by five of the 17 big electric cranes in the building.

Ernest Johnson took me through the testing section where a $200,000 steam equipment is provided for putting these turbines through their paces before being loaded on the cars which are run into the far western end of the building.

The figures for the fourth Liberty loan in building number 49 show that the men subscribed for $50,500 worth of bonds—an average of nearly $100 per man. When I tried to learn the amount which they had subscribed to the third Liberty loan I learned there were only 75 men in building number 49 at the time of the third loan—again showing what a magic transformation was made from foundry to machine shop during the summer; and to fully grasp this, see the two photographs, one taken in September showing the machine shop fully equipped and turning out work equal to the fondest expectations of the most optimistic prophet; and compare it with the other photograph taken from the same point in the same building and looking in the same direction, showing it as it looked as a foundry only last spring.



Special Freight Car for General Electric Company. Note the small clearance between the bottom and the rail.

CHAPTER II

ROMANCE OF SHIPPING

EMPLOYES IN DEPARTMENT HERE UNDERSTAND CUSTOMS OF PEOPLE ALL OVER THE WORLD.

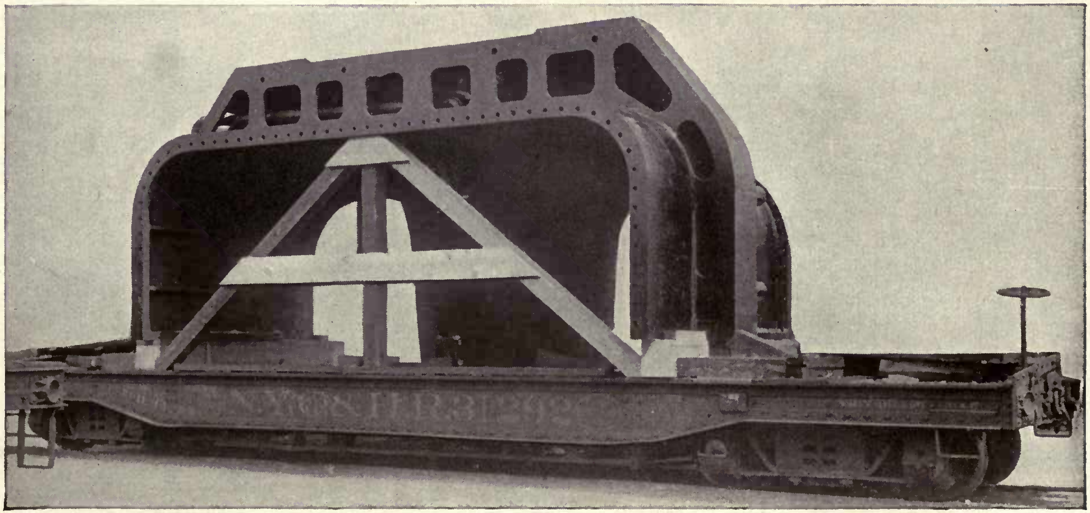
In the shipping department of the Schenectady works there are men who understand the local customs of the Hindus in the Himalaya mountains, of the Indians in the Andes mountains and the Eskimos in the Yukon district of Alaska, men who assist and understand the peculiarities of the men as well as those of the climate and the country.

Experience has shown that entirely different arrangements must be made for shipping electrical apparatus to South America, India, France, and Alaska.

Machines for the west coast of South America must be "dismembered" into numerous small packages of comparatively light weight because there are no wharves, piers, or docks worthy of mention on the entire western coast. And besides a burro cannot carry up into the Andes mountains a package weighing over 170 pounds in weight, and a mule's limit is 350 pounds; so that the machines from Schenectady must be "knocked down" before being sent on their long and arduous journey.

INTO THE HEART OF THE ANDES

Just think of the preparation necessary to insure safe delivery of electrical machinery by railroad to New York, by boat to South America, and from the boat unloaded into canoes. These canoes are paddled as close as possible to shore and then the boxes or packages of carefully made electrical machinery are tossed into the surf. Then they are dragged ashore and trucked to a railroad station and begin a journey of from two to four days more, probably on an open or flat car to the end of the line near the foot of the mountain; then four days more in an open boat, with Aztec Indians or peons as pilots. And then after the river ceases to be navigable to a boat, the Yankee motors and



The Detroit 45,000-kv-a. Steam Turbine Generator Required Fifteen Freight Cars for its Shipment.

generators are loaded on the backs of mules for their long journey up the narrow, winding paths of the Andes mountains.

Do you think that the Aztec Indian is careful to lower the packages of precious machinery gently from the mule's back to the ground? If you do you are mistaken. Our Indian friend is probably as tired as the mule and merely loosens the strap, allowing the box to fall to the ground, whether it be rocky or marshy, whether the sum be shining or the rain falling.

To appreciate these difficulties remember that salt water as well as fresh water has been encountered, that the machinery has risen from sea level in a tropic land to the snow-capped mountains of the Andes, and that after arriving at the location of the power house it is likely to be left lying on the mountain side for months before the engineers are ready for it.

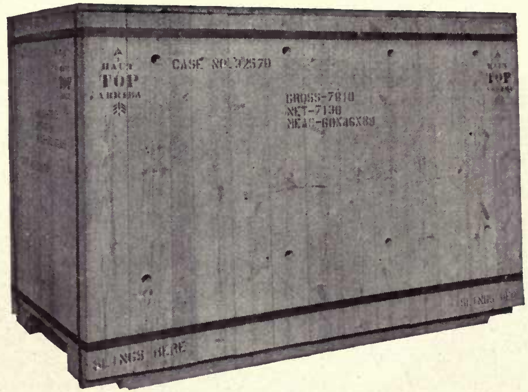
But the experts of American industry today have learned how to pack the machinery to defy breakage, rain, and moisture, and they can guarantee in advance that the machinery will operate without a hitch.

Other problems must be met, even on the better developed parts of the west coast of South America. In some places machinery is hoisted from the boats and lowered into a lighter to be taken ashore. Regardless of its name the Pacific Ocean has many a rough sea, and you must picture in your mind a load of several tons of generators or motors being lowered from the vessel to the lighter, and the lighter itself coming up on the crest of a wave with practically irresistible force. The size and weight of packages must be so limited that the men handling the derricks are able to safely land the machinery in the lighter, and not permit it to go crashing through the bottom into the sea.

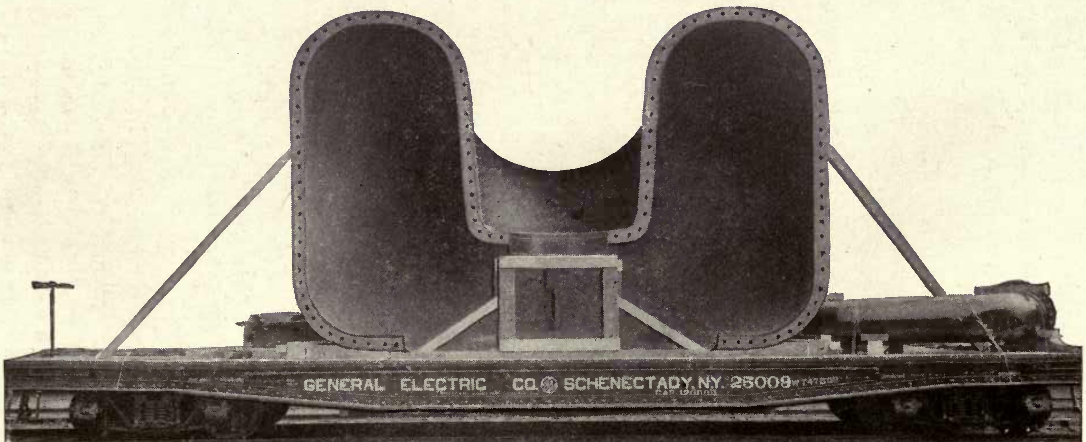
HINDU TRANSPORTATION

And in India crude trucks drawn by teams of oxen carry loads as heavy as three to five tons, while the elephants can haul ten tons. In a recent installation of Yankee machinery in India it required one complete year before the apparatus could be carried 250 miles into the interior by elephants.

A curious sight was witnessed when the Hindus organized committees of welcome, with bands of native musical instruments, and came to meet the Yankee engineers; for the story had been spread



Typical Packing Case for Export Shipment.



Upper Half of Exhaust Covering of the Detroit 45,000-kv-a. Steam Turbine. Note bracing for steadying and distributing the load.

that the Americans were to introduce that weird God of lightning which would lighten labor and pierce the night of their wilderness country in the Himalaya mountains.

On this 250 mile journey to the Himalaya mountains in India, where the water power was being developed by American machinery, it was found that many of the bridges had to be rebuilt in order to carry the heavy loads, the equal of which had never before passed to deep into the heart of the country.

THE TERMITE

In India, just as in South America, the jarring of loading and unloading must be guarded against; but besides this there is in India a different enemy of electrical machinery who is most formidable, although he is only three quarters of an inch long from stem to stern. This enemy is the dreaded termite.

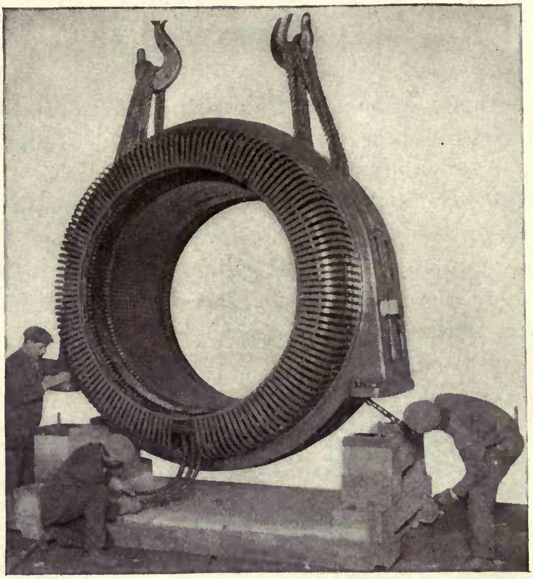
If a box of machinery were left overnight unprotected on a truck, the next morning there would probably be nothing remaining of the entire shipment but the bare metal. The termite is an insect which feeds chiefly on wood and does not leave even as much as sawdust after he has completed his meal. On one occasion a row of telegraph poles was completely eaten up by these termites and in 48 hours nothing was left but the wires and the glass insulators.

Engineers have found that there are only three things which resist this insect, namely, stone, iron, and the humble coal tar. So all boxes that are sent to this section of India must be thoroughly coated, you might say thoroughly saturated, with coal tar, just as the workmen spread it thickly on the roof of a building.

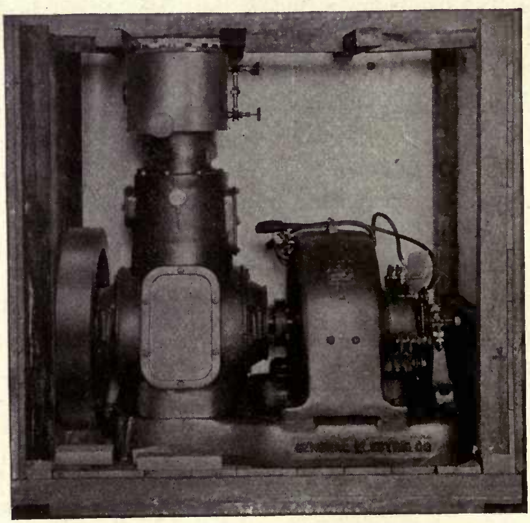
COLD CLIMATE

Now let us turn from the elephant of India to the dog sleds of Alaska at almost the opposite end of the earth. Electricity is needed in the frigid zones, as well as in the torrid zones, and the dog of the Eskimo is the accepted means of transportation. In this case a thousand pounds is the limit in weight of each package, in order that they may be effectively handled by a standard "dog train." A 1,000-pound package is of such size that the men and the dogs are able to handle it easily.

So well does the shipping expert meet the peculiar local condi-



Finishing Touches Between Armature and Skids to Prevent Rust.



Boxing for Export Shipment of a Marine Generating Set.

tions of the dog sleds, that special horns are provided on each package so as to assist the Eskimos in lashing the packages to the sleds.

Thus the men of the shipping department must understand the customs and environment of the Hindus in the Himalaya mountains, the Indians in the Andes mountains, and the Eskimos in the Yukon District of Alaska.

How Yankee electrical machinery is shipped in China. Note the way in which a Chinaman makes a wheel. Apparatus must be so well boxed before leaving Schenectady that it can stand all kinds of abuse in transit.

LARGE APPARATUS

That the development of the art of shipping has kept abreast with the development of the electrical industry itself is very well shown by the following instances.

When the first turbine was built in Schenectady, in 1902, to be shipped to Chicago, it caused great perturbation in the shipping department. Two railroad cars were broken in attempting to load one of the cases; the railroad company deliberated for a week before it could decide whether it could transport the turbine to Chicago, and a special train requiring an extra expense of

$1000 in addition to the regular freight charges was necessary to get this piece of apparatus to its destination.

But now we are shipping turbines of 50,000 kilowatt capacity, over 60,000 horse-power instead of merely 5,000 kilowatt as a maximum. The shipping experts say that today when a turbine of only 5,000 kilowatt is to be shipped, it is no more of a job than putting it under your arm and carrying it away, figuratively speaking. A machine which will do the work of 6,300 horses today is looked upon relatively as a watch charm, a mere trinket, only a "market basket" load, while the really interesting problems in shipping arrive in connection with the giants of 60,000 horse-power each.

SPECIAL CARS

The company has arranged for special cars of unusual strength, with increased depth reaching down to within a few inches of the rail, and otherwise adapted for the peculiar variation in size, shape, and weight of modern electrical machinery.

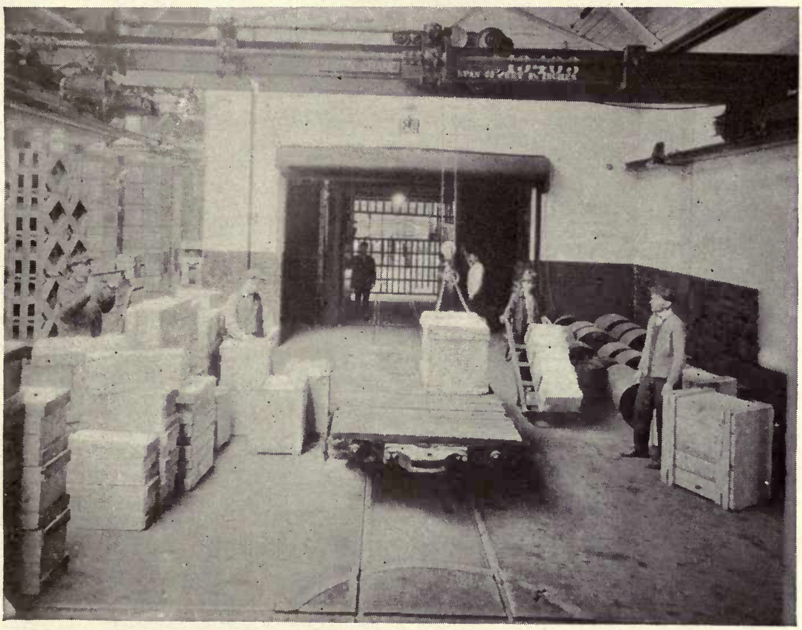
The art of fastening these large pieces of machinery to a freight car has been developed to a high degree of perfection. In a recent wreck on a western railroad the car containing General Electric apparatus was upset; but when the wreck was cleared, it was found that the platform of the car and the apparatus were still integral, the platform having left the trucks but remaining fixed immovably to the apparatus.

OTHER PROBLEMS

Here are some interesting examples of overcoming seeming impossibilities. When the large generators for the Metropolitan Street Railway were to be shipped to New York City, it was found that the loaded car would be one and one-half inches too high to clear the bridges. It was therefore necessary to give the springs of the railroad cars a special compression at the factory in order to permit the cars to get through. This heroic method overcome the contention that "It can't be done."

And there are many wonderful stories to be told of single turbines that require 15 separate cars for shipping; of special cars carrying from 50 to 70 tons each; and of how the apparatus has been so nicely poised and balanced on the car that clearance between the sides of the tunnels or bottom of the bridges has been

figured out to one half inch. In such nice calculations as these it has been necessary to abandon the use of wood for boxing, substituting sheet metal to obtain a covering thin enough to avoid crashing into bridges or scraping the sides of tunnels in the Rocky mountains, as either occurrence would probably wreck the entire train.



A view on the third floor of Building No. 50. This shows how the narrow gauge railroad cars are brought upstairs by the elevators, shifted right and left by turn-tables and unloaded by electric cranes. Note the railroad tracks on the elevator platform. How different from the preceding generation, when these boxes would have to be lifted by human hands. Can any one doubt for a minute that electricity is one of the greatest boons to the human race?

When some of the big water turbines were to be sent to a power plant in the Rocky mountains, there was a man in Schenectady who knew of a weak bridge in Minnesota, a low bridge in Montana, and a narrow tunnel in Idaho, and he knew just what the limitations were, and which railroad would be best for the shipment. Some apparatus for New England is shipped by way of Scranton, and taken by water to its final destination, because the

railroad facilities of New England are inadequate for such shipments.

PROBLEMS OF RAILWAYS.

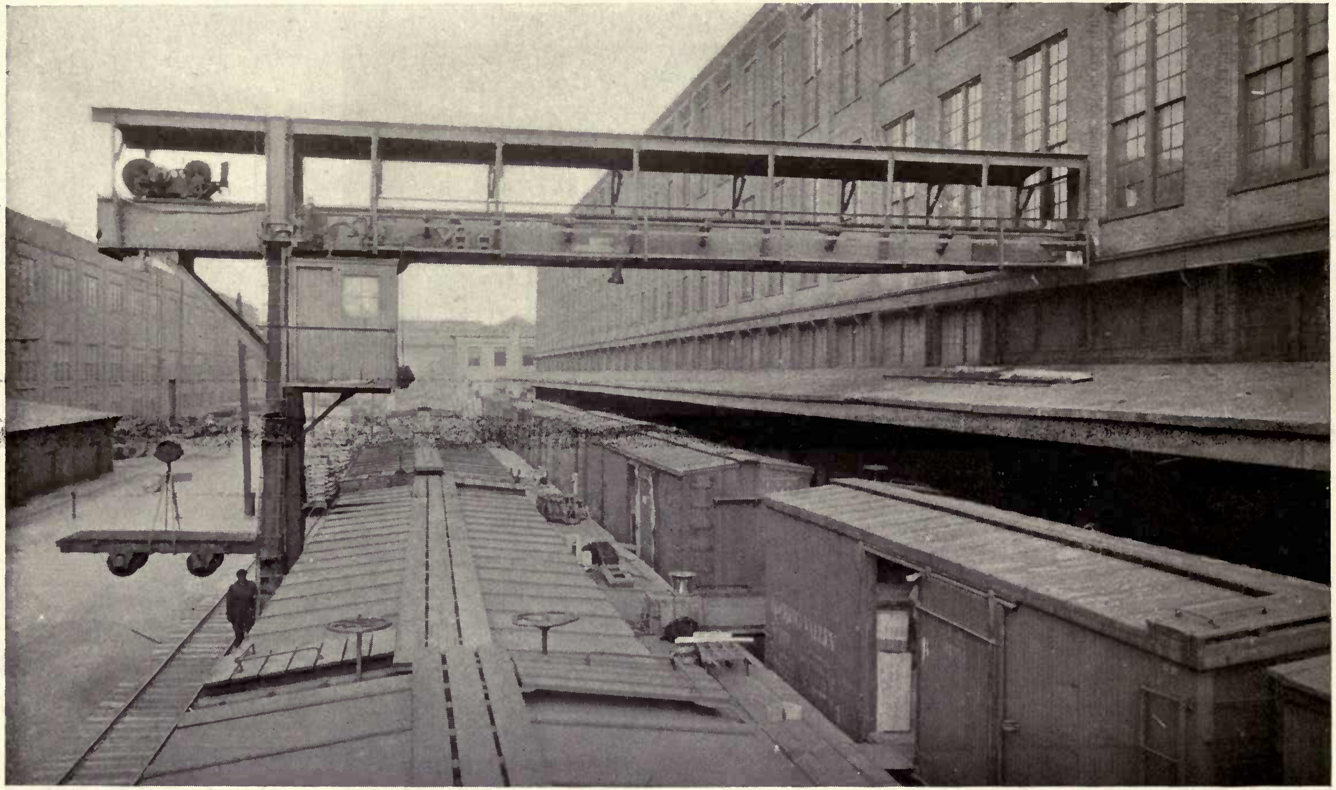
The problems of the American railways are not the only ones which must be met. The French railway car will not carry as heavy a load as the American, and the French bridges and tunnels have smaller capacity than ours. Therefore, when large shipments of electrical machinery go to France or South America, for the conditions are the same, the entire method of packing, skidding, etc., must be altered.

An interesting example of this was in the case of steam turbine generators being sent to the Tuileries in France. They were packed one way for shipment from Schenectady to New York, a different way for the boat trip from New York to Bordeaux, and a third way for the rail trip from Bordeaux to the Tuileries If they had been shipped by boat in the same package in which they left Schenectady, the cubic contents, and hence the shipping charges, would easily have been trebled.

The loading of these cars is not only limited but it must be made permanent. The creeping of the load on a car must be prevented. The bumping and rolling of a railroad train has been found to loosen the struts and braces unless the work is well done, and occasions have been known where the trains have been wrecked, bridges damaged, and tunnels jammed with a tangle of machinery, locomotives, and freight because a packer did not know his business.

One of the means of preventing shifting of the load on a railroad car is to load the car uniformly, not only longitudinally but laterally. The struts and braces are placed with great skill so as to prevent a concentration of the load at the end, the center, or on either side of the car.

Experience has shown, particularly in export shipment, that cautions reading *Right Side Up*, *Handle With Care*, *Fragile*, and even *Glass* are not respected. Efforts to keep machinery in an upright position throughout an entire voyage are shown in the photographs. Large black arrows are painted on all four sides of the box with the word *Top* placed permanently near the head of the arrow as well as the French word *Haut*, and the Spanish word *Arriba*. But if you were a Hindu unloading an elephant it is



View of side of Building No. 50 showing clever method of removing empty cars from the side of the building by means of a traveling gantry crane. Thus the tracks which enter Building No. 50 can all be used for incoming traffic of loaded cars.

quite doubtful if you would exert yourself to let this package down gently, right side up on the barren wastes of India, or during a tropical storm in South America or China.

BAFFLING THE WEATHER MAN

Expert packers have no difficulty in protecting machinery from rain and snow, wind and heat, or from the mist on the sea. This is as easy as for an ordinary citizen to wear a mackintosh or

No, this picture was not taken in the Equitable Building in New York, but it is a girl's rest room in the Shipping Department in Building No. 50, located about the center of the Works.

carry an umbrella. But the real deep study has been to overcome the accumulation of moisture on the machinery due to humidity, especially the humidity of foreign countries.

The rain and snow is excluded by tar-coated building paper strengthened by mosquito netting. This light filmy mosquito netting is quite useful in adding strength to the tar paper and serves the purpose admirably.

THE FIGHT AGAINST RUST

For packages that go to foreign countries an additional covering of what is known as carriage cloth is used underneath the covering of tar paper. This carriage cloth is wrapped around the machinery itself, and is held tight by strings and ropes so that no matter what position the machinery may be in it is well protected.

For many years it had been found that the shipments of American machinery were damaged by rust although they were perfectly protected from rain and storm. This rust evidently was produced by the moisture in the air, that is, the humidity.

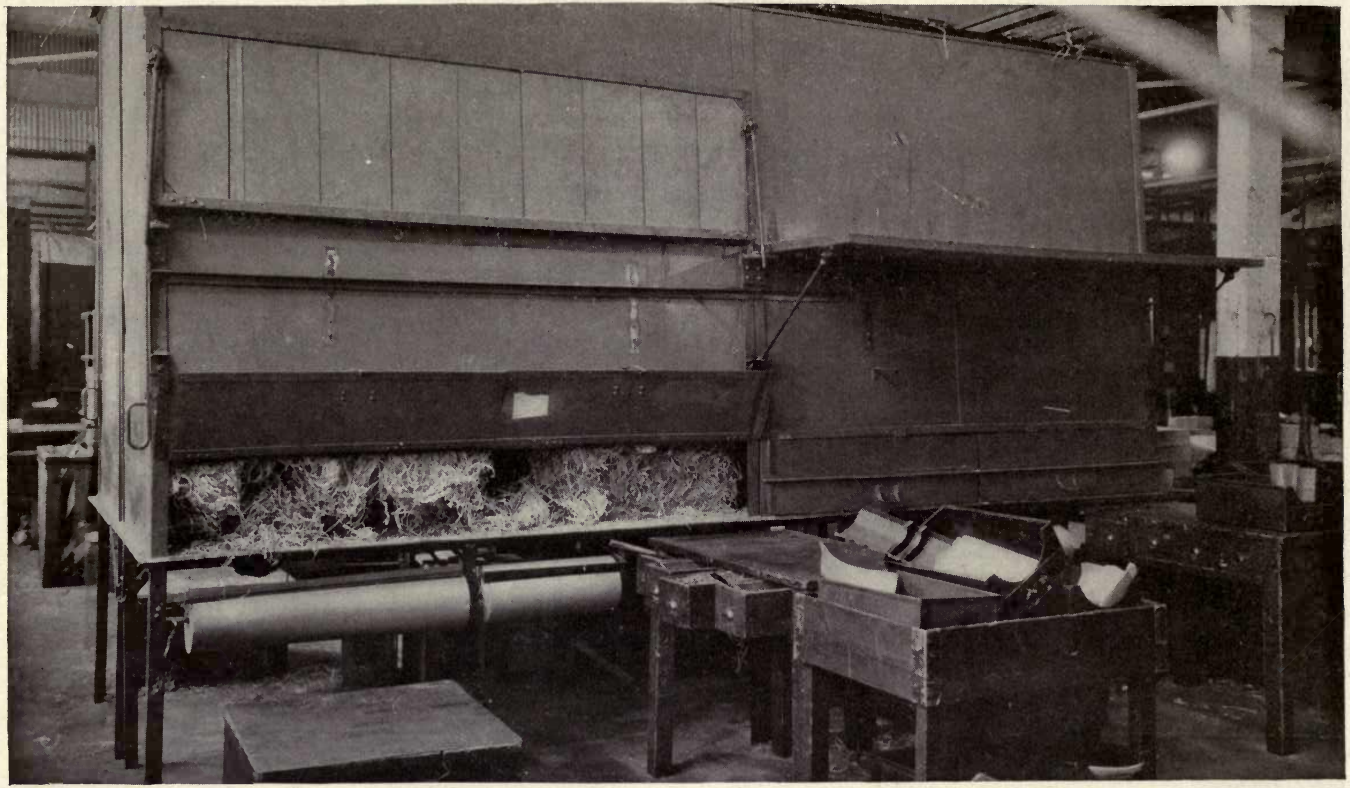
Various experiments were tried using special kind of cloth, special coatings of tar, and in some cases an entire metal box of zinc or lead constructed and apparently hermetically sealed. But these all failed of their purpose. In one instance a motor was totally enclosed in a zinc tank and soldered tight. Two years later it was opened and there were three quarts of water in the bottom of the tank.

Apparently, due to jarring and vibration, some little crack or pinhole had opened up and the box had begun to "breathe." The dampness would condense against the cold machinery, and then in the daytime when the temperature rose the box would breathe out dry air. Thus with the rising and the setting of the sun moisture was carried into the box which was thought to be hermetically sealed.

The shipping board were baffled; they gave up the problem as hopeless. Someone thought of consulting Dr. Steinmetz, the chief consulting engineer of the General Electric Company. And no finer example of the complete organization of an industrial company is found, than here, for it shows that the company's experts in different lines can exchange information for the benefit of all.

Dr. Steinmetz advised that the boxes be made open instead of closed, and that "breathing holes" should be provided so as to keep the temperature inside of the box practically the same as the temperature outside of the box. The shipping department conducted many experiments and eventually a method was developed which finally and forever solved the problem. The great generators for the London underground railroad were delivered

General view of the shipping office in Building No. 50. High ceilings, good light, calisthenic exercises twice a day with the windows open — these are some of the features which keep this office organization on tip-toe. Note business phonographs in the foreground.



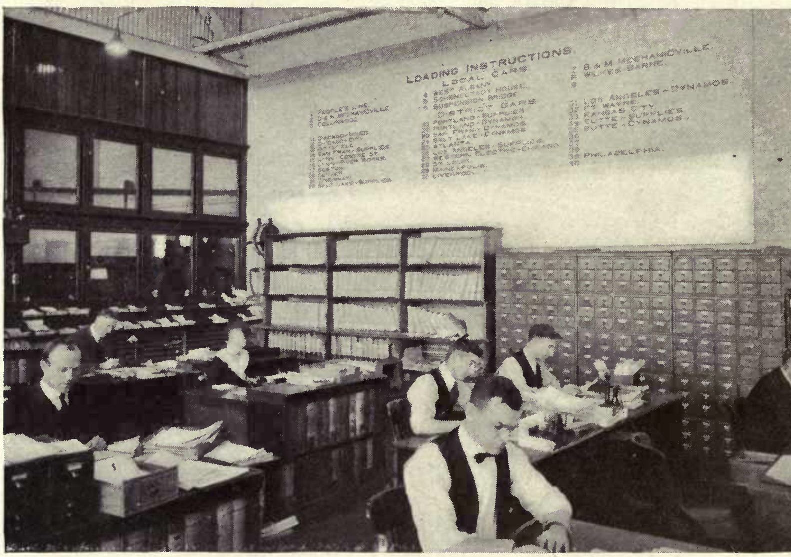
The metal ventilated excelsior bin in the Shipping Department. All supplies are boxed with the assistance of the equipment such as is shown here. Wrapping paper, with drawers for nails and tools, a stool on which the box is placed so as to prevent stooping over, truck and the steel boxes containing the goods to be shipped.

The Stenographic Section of the Shipping Department. These desks are all firmly fixed to the floor by brass angles. Every morning at 10 and every afternoon at 3, there is 8 minutes of exercise with the windows open. The girls are very enthusiastic over this. This is a model office in Building 50.

Information Bureau at the Shipping Department. In the twinkling of an eye these girls answer questions as to whether machinery was shipped and how it was shipped. They answer 600 calls daily in connection with the 1200 shipments which leave the Schenectady Works every twenty-four hours.

free of rust, but it was found that the mice on shipboard had taken advantage of the breathing holes in the boxes, and had eaten the insulation off some of the copper wire. So from that time on a wire screen or netting was tacked on the inside of each hole.

The breathing holes are not made too close to the top or bottom or sides for fear water might wash into them. To provide against the possibilities of these boxes being laid over on one side,



A corner in the Shipping Department. Nearly all of the transactions in this department are conducted by code. The key to one of the codes is shown on the wall headed "loading instructions."

thus making the holes on the top, a funnel-shaped shield is tacked on the inside of the box around the hole, and this shield or funnel traps the water and diverts it down the side of the box, away from the machinery.

Shipping experts of the Schenectady works who have had unequaled opportunity to study these question say that shipments of General Electric apparatus which may be lying now at the port of Vladivostok in Russia, are as free from rust and other damage due to the elements as if they had been standing in the

shops of the General Electric Company an equivalent length of time.

The method just described is for large pieces of apparatus. For small delicate apparatus, such as instruments, which are liable to damage from moisture in very minute quantities, a pitch-covered canvas is used inside of the box, and not a complaint has been received from any quarter of the globe in the three years that this method has been followed.

This is applicable especially for boxes which are small enough to be handled by one man. This pitch-covered canvas is more effective than any metal casing because of its clinging qualities, and the fact that if subjected to pressure or distorted it is not in any way weakened; for the more it is compressed the tighter the wrapping becomes—exactly opposite to the case of a metal box.

PANAMA LOCOMOTIVES SHIPPED COMPLETE

From the customer's standpoint it is ideal to receive the completely constructed machine. For instance, the Panama locomotives were built at the factory, shipped on the decks of the vessels, and when lifted onto the pier at Panama they were run off by their own power.

The ideals towards which the packing experts strive, in the order of their importance, are as follows:

1. Get the shipment to the customer without breakage.
2. Get the shipment to the customer without rust or other damage by moisture.
3. Deliver it as nearly completely assembled as possible.
4. Deliver it as quickly as possible.
5. With as small an expense for transportation as possible.

So important is the work that a shipping committee has been appointed to standardize this portion of the General Electric Company's work at all of the different factories. The Committee consists of eight men from the various works, and they meet four times a year or oftener to discuss problems and settle matters of detail and policy. This committee thus acts as a clearing house of shipping information and experience.

Each type of apparatus has assigned to it a definite box, of definite size and material, put together in a certain way, wrapped,

tagged, etc., according to definite specifications, written down and even illustrated.

There are 750 kinds of boxes represented, and directions covering many different methods of loading flat cars, in which are specified the braces, struts, skids, etc., which should be used. All these add not only to the safety but to the speed of shipment.

GOVERNMENT RECOGNITION

The United States Government recognizes the value of expert shippers and has created a Committee on packing, boxing, and crating, as it is now shipping untold millions of tons to all parts of the world.

This Committee consists of Mr. D. L. Quinn of the Forest Products Laboratory at the University of Wisconsin, Mr. P. C. Morganweck of the International Harvester Company at Chicago, and Mr. M. C. FitzGerald of the General Electric Company at Schenectady. The Committee has prepared standard specifications for packing different types of supplies, apparatus, etc., and personally instructs those officers who have charge of this work at Washington and at the various points of embarkation.

Many officers have visited Schenectady in order to receive instructions in the standardized method of packing and shipping. It is gratifying to hear that Major General George W. Goethals requires that these specifications be followed to the letter in the actual work of shipping goods abroad.

As an example of the benefit of the recommendations of this Committee, take one instance—a shipment of 10,000,000 cases for France. The Committee was asked to give its recommendations on the boxing of each of these 10,000,000 cases. Although the proposed cases had been whittled down as far as the manufacturer thought it could be done with safety, the Committee developed a new method which cheapened the manufacturing cost of each box 25 cents and also reduced its cubic displacement one half cubic foot. This saved $2,500,000 in the cost of the boxes; but this is not the whole story. The 5,000,000 cubic feet of shipping space which was saved is worth from two to five dollars per cubic foot at standard freight rates, or a further saving of approximately $20,000,000. And again, from the standpoint of conserving ship space, 5,000,000 cubic

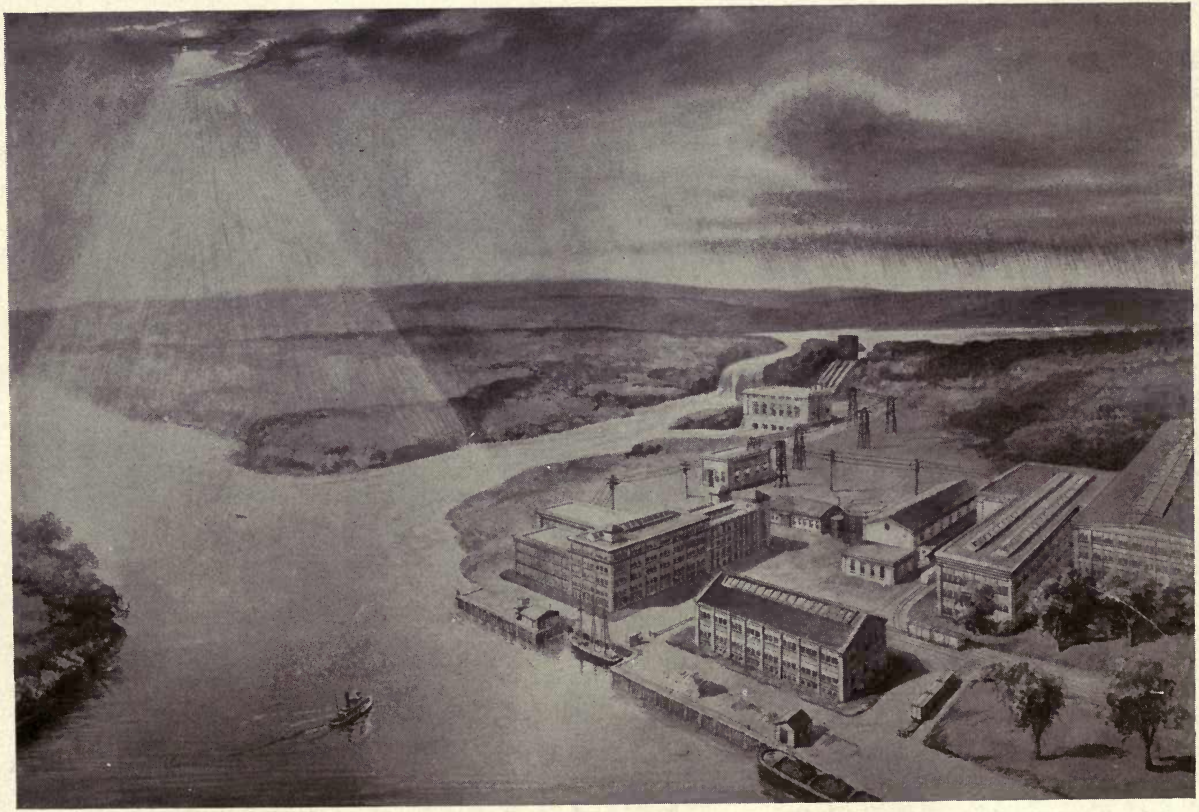
feet displacement is equivalent to 125,000 tons, as 40 cu. ft. of this character is rated as one ton in marine estimates. Thus this one recommendation of the boxing and crating experts also conserved shipping equivalent to the combined cargo space of thirty-one 4000-ton ships.

If you should visit the shipping department you would see boxes made by electricity and nails driven by electricity. Every day they use one and one-half tons of nails. The nails used annually, if put end to end, would reach 3,500 miles, the distance from London to India, or from New York across the continent and 1,000 miles out into the Pacific Ocean.

To the layman the fact that 13,500,000 feet of lumber is used every year does not seem very surprising. Few of us remember that a foot of lumber is one foot square and one inch thick; but this amount of wood in boards one-half thick would cover a California ranch of 600 acres; or if made into posts one inch square would reach 30,000 miles, or clear around the earth and enough to spare to reach from Schenectady to the heart of Europe.

And then there is the banding iron which strengthens the boxes. The shipping department in Schenectady alone uses 690 miles every year, and practically 20,000,000 square feet of wrapping paper, waterproof paper, and rubber covering lining. These are small details of a year's work in the shipping department.

There are 693 persons in the shipping department of the Schenectady works, and 350,000 square feet of floor space in 15 different buildings is devoted to this work. This space is greater than seven New York City blocks, each as large as the one occupied by the Equitable building, the largest office building in the world.



WHITE COAL BEING MADE BY THE SUN.

This painting by W. L. Green of the Publication Bureau's Art Department shows that it is the power of the sun which raises the water to the mountain tops and makes hydro-electric power possible.

CHAPTER III

WHITE COAL FROM THE SUN

CONVERT MOUNTAIN TORRENTS INTO ELECTRICAL POWER FOR INDUSTRY—STORY OF ELECTRICAL PROGRESS OF TWENTIETH CENTURY LEADS TO SCHENECTADY.

Electricity and Schenectady have so long been synonymous terms that the story of electrical achievement has long since become a matter of fact, in which the actual marvels which have resulted from years of experimentation and work are known.

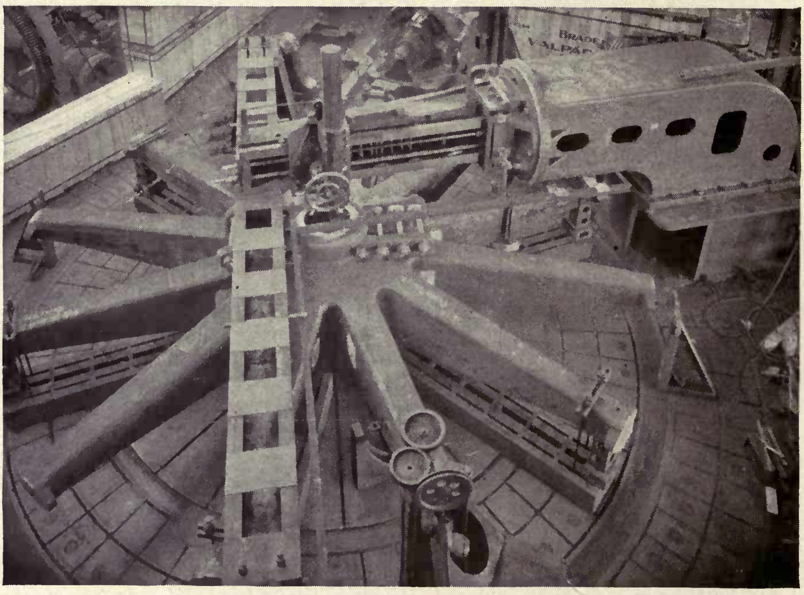
Not the least of the achievements has been in converting the vast amount of water power which exists in the United States into heat, light and power. Schenectady is almost directly responsible for a great amount of all three, for the massive turbine generators are the first and most essential link between the mountain torrent and the power which is generated for half the world around.

The parable of the rain drop might run something like this, in the tale of electricity:

On a warm summer afternoon four drops of water lay in the bay. Responding to the blazing rays of the sun, these drops of water evaporated and ascended heavenward, where they helped to form a cloud, and then, directed by the Invisible Hand, this cloud coursed northward. One drop of water fell in a garden and helped furnish man with food. Another drop of water fell in a field of cotton, and helped to give man clothing. The third drop of water fell in a forest and helped nourish a tree, and so worked to provide man with shelter. But the fourth rain drop was not destined to furnish man with food, clothing or shelter, but to give him heat, light and power.

So on and on it went, further northward until it dropped in the form of snow on a barren mountain peak. There it waited many months until the earth had gone half way around that same sun; and one warm day in May the sun's rays brought the message that its long stay in the mountains was at an end. Throwing off its winter clothing it again resumed the form of a rain-

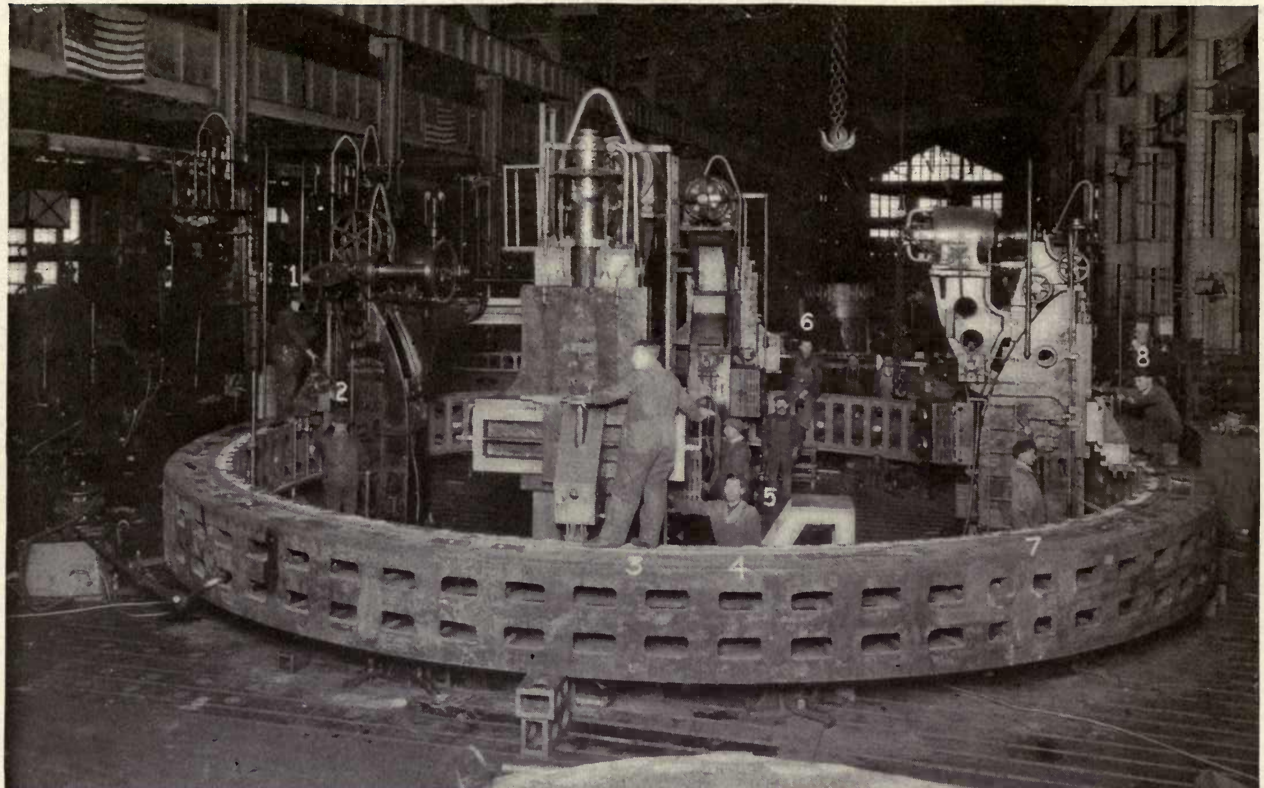
drop, and crept down the edge of the vast ice flow. Then it joined some brothers in a tiny rivulet, then tumbled into a mountain brook and soon in a raging torrent it sped down to a lake. There its progress was checked by a dam, but not for long. For soon, racing down the penstock, it dashed itself against the steel blades of the turbine in the power house. In that brief instant it fulfilled its destiny, for it helped to create heat, light and power.



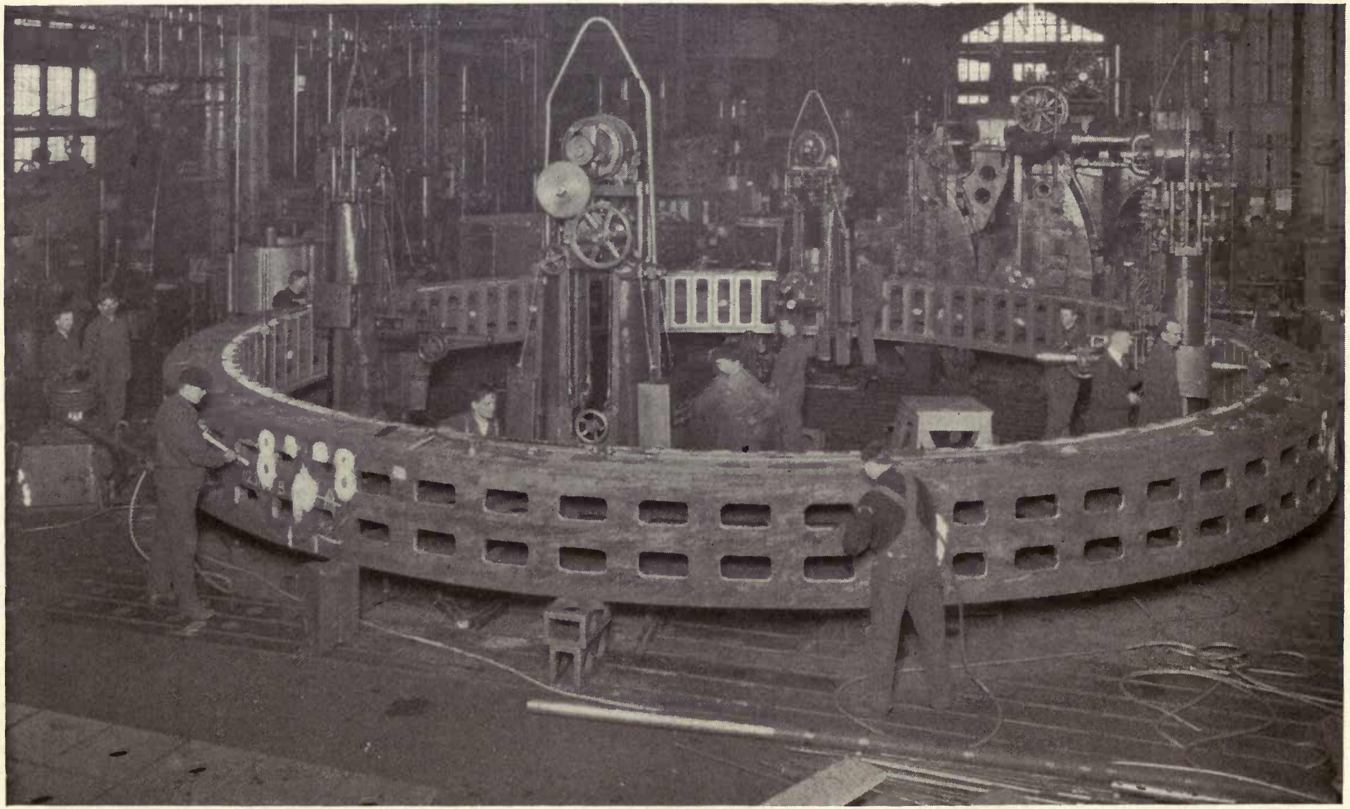
One of the biggest boring mills in the Works installed in Building No. 16. A spider for a great water-wheel generator is in place and several cuts are being made at the same time — one inside.

CYCLE GOING ON FOR AGES.

For ages and ages this great cycle has been going on, water, mist, clouds, rain, snow, ice, water again; up and down from tropic to artic lands and back again—countless billions of tons of water lifted and carried countless billions of miles. Our forefathers for thousands of years stood beside the great mountain cataracts, unable to use the priceless energy which was wasting itself in roar and mist; for there was missing that vital link — electricity.



How four portable slotting machines in Building No. 16 worked simultaneously on one big generator for the Cedar Rapids Power Plant in Canada. The men are: 1 — C. M. Lewis, 2 — F. Verzulia, 3 — P. Unger, 4 — P. Falconi, 5 — A. Ditterick, 6 — W. Vedder, 7 — F. Marzola, 8 — S. Bittman.



In Building No. 16 the generators for hydro-electric plants become so big that the machine tools are made portable and brought to the work, instead of bringing the work to the machine tools. This picture shows four portable milling machines, operating simultaneously on a big electric generator. The ten machinists in this picture are from left to right: A. Angerosa, John Durzilla, P. Nitchman, J. McGrath, D. Ditterick, C. Somers, H. A. Grams, Fred. Sweeney, J. Nicholls, J. T. Allen.

But now electricity takes the power of our mountain cataracts to cities where it turns the wheels of industry, to our mines, where it first dislodges and then hoists the coal or metals to the surface; and it is electricity that spins out the power of the waterfall as a fan of copper arteries along the path of the transcontinental electrified railway.

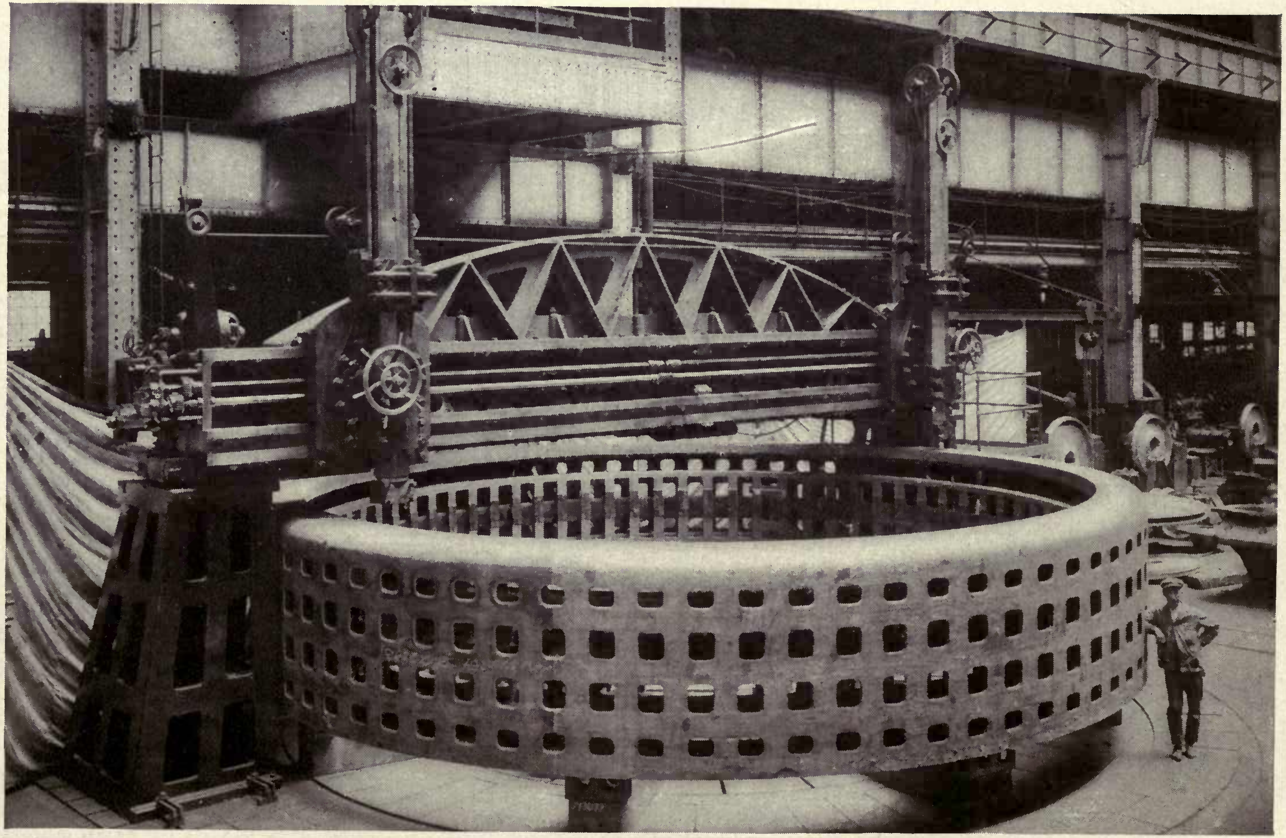
It has been said that "all roads lead to Rome," just as does the story of electrical achievements of the twentieth century end in the city of Schenectady. It is Schenectady that supplies the huge electric generators for dozens, scores, hundreds, yes thousands of these mountain and river power plants.

Schenectady engineers often select the location for a plant, other Schenectady engineers supervise the planning of the dams and the penstocks; others design the machines for each job, generally a special generator adapted either to use a large flow of water falling for a small distance, or a small flow of water plunging from a great height. And these generators are built by Schenectady men in building 16—the greatest variety, always something different, each new wonder a mechanical as well as an electrical education in itself.

There is no type of electric generator which has such great weight and size as the water wheel generators. The men in building 16 have shown the utmost ingenuity in handling large fields and armatures weighing sometimes over 100 tons with the facilities available. The generator field of a 20,000 horsepower steam turbine is a cylindrical motor three and one-half feet diameter and approximately twelve feet in length; but the field of water wheel generator of only 12,000 horsepower capacity is twenty-five feet in diameter and with a total weight of 115 tons; and it rotates at fifty-seven revolutions a minute.

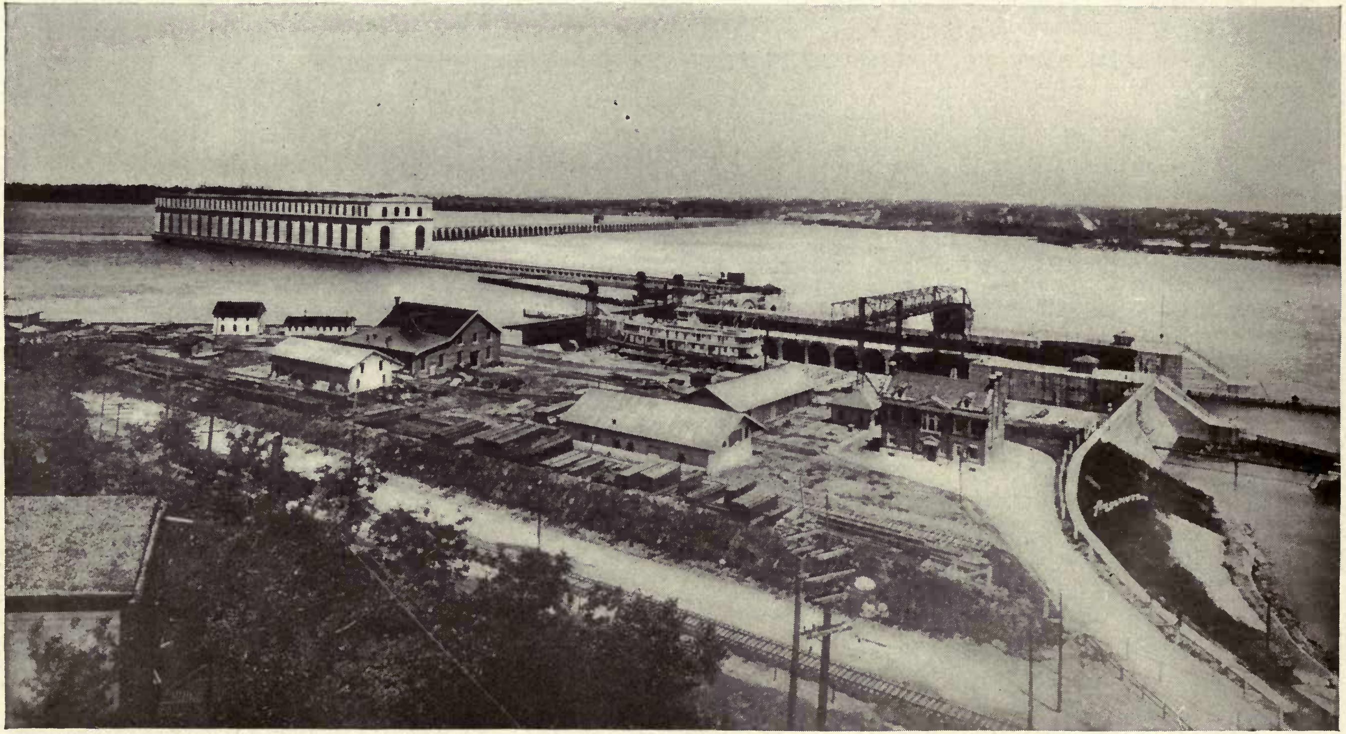
And then considering the stationary armatures of the two types, the water wheel generator of 12,000 horsepower capacity has an outside diameter of thirty-two feet and weighs 160 tons, whereas the armature of a steam turbine generator of equal power would only be eight feet in diameter and weigh only fifteen tons, less than one-tenth the weight.

The necessity of having heavy weights in the water wheel generators is due to the slow speed, as it is obvious that the faster a



Big water wheel generator being machined by Walter Moag in Building No. 60. This same machine is shown in picture inside of the Great Mississippi River Power Plant at Keokuk. Fifteen of these monsters changed the power of the Mississippi River into electricity. The energy they generate is equal to power of 300,000 horses, working in three eight-hour shifts. This power used to be thrown away before the electrification was carried out.

Interior view of the great Keokuk Power Station at the Mississippi River. Fifteen of these generators each with the power of 12,000 horses are already installed. They are able to create an amount of power equal to that of 540,000 horses, working in three eight-hour shifts. Ultimately there will be thirty of these generators installed.



General view of the Dam and big Power Plant at Keokuk, equipped with generators built at Schenectady. The inside of this power plant is shown in another picture.

generator turns, the smaller it can be made; and the large water wheels are comparatively slow machines.

FACE COLOSSAL PROBLEMS.

So from the manufacturing standpoint the men in building 16 who built millions of horsepower of these generators, face the most colossal problems of size and weight which exist in the General Electric Company.

So great do these machines become as they are assembled and even half assembled, that it is necessary "to bring the tools to the work, instead of bringing the work to the tools." Four large sized drills or slotting machines, some of them three times as tall as a man and weighing forty tons, are more easily moved to the generator being assembled on the iron floor, than it is to lift the huge generator and convey it to stationary tools.

The mammoth size and weight of these machines can be appreciated by viewing the photographs, but better still is a personal trip through the building where they are fabricated.

There are many who think building 16 typifies Schenectady, because everything is electrical. You see huge 6,000 horsepower motors for steel mills, which can stop and reverse to full power and full speed in the opposite direction in five seconds; for 5 seconds they can deliver 22,000 horsepower each! Here are made the motors of 7,000 horsepower for driving Uncle Sam's electrically propelled battleships through the seas, the latest development in the engineering world. And here are built motors and motor generators for the Chicago, Milwaukee and St. Paul electrification; and you can witness the test of throwing absolute short circuits dead across the terminals of these generators whose commutators and brushes are protected from damage by the new "Barrier."

There are big electrical things in Schenectady and new electrical things in Schenectady; but in building 16 is where the new big ones are experimented with, manufactured and tested; and here it is that the designing engineer is elbow to elbow with the shop men on half a dozen new developments at the same time.

One of the curious features about the hydro-electrical development is that the electrical apparatus, as essential as it is, is much less expensive than other parts of the development.

In the book, "Hydro-Electrical Power Stations," written by Rushmore and Lof in 1917, there appears a statement of the estimated cost of a hydro-electric development:

Main dam and head works	$313,660
Canal, including lining	62,000
Forebay	23,000
Penstocks	35,750
Power house	61,000
Machinery—	
Turbines and governors	42,000
Generators and exciters	52,000
Transformers and switching apparatus	36,000

Thus, out of the above $625,410 the generators and exciters cost only $52,000 or considerably less than ten per cent of the entire plant. Or looking at it in a different way, the generators and exciters cost but little more than the turbines and governors, less than the power house building itself and also less than the canal.

HUGE OUTPUT EACH YEAR.

The output of electrical machinery from building 16 has reached as high as 1,000,000 kilowatts a year, the largest month being 128,000 kilowatts or approximately 170,000 horsepower in one month. If this output for the last fifteen years were averaged it would probably not fall far below 1,000,000 horsepower per year. And none of this apparatus is in small size, as the capacity varies from 500 up to 40,000 horsepower.

But so far they have only scratched the surface. The work to be done in future years literally staggers the imagination. What the brain of man has conceived, and what the skill of man has built in the past—these are as but one grain of sand on the seashore.

In the United States there are at present only about seven millions horsepower of waterfalls developed and making electricity, and this is not one-tenth of the total which still remains to be electrified.

And a survey was even made of the possible waterpower of the world as follows:

Continent	Area Sq. Miles	HP.
Africa	11,500,000	161,000,000
North America	8,000,000	112,000,000
South America	7,000,000	96,000,000
Asia	17,000,000	239,000,000
Australia	3,000,000	10,000,000
Europe	4,000,000	53,000,000

The grand total of this is close to 650,000,000 horsepower. Of this vast amount some is now under way and much of it could be profitably developed in the near future.

In looking over these great possibilities and probabilities one is forced to believe that there will always be plenty to do in our lifetime, when it comes to harnessing waterfalls, and that it is a mighty fine business to be connected with.

The writer has taken great interest in looking over the book "Hydro-Electric Power Stations," and believes that every man who works in building 16 should visit the G. E. library in the basement of building 2 and look over this book. He will see pictures of various machines which he has built with his own hands, and see how they look when installed in various power plants all over the world. In addition to the photographs there are a great many engineers' drawings and scores of pictures of the different types of water turbines and their governors.

There is also much general information regarding the history of the water power development in the world, the problems which the engineers study in connection with rainfall and the flow of rivers. The civil engineering problems of dams, water conductors, storage reservoirs, etc., are gone into exhaustively; much information is available on designing the power house, the kind of turbines to use for different heads of water, the various plans that have been adopted for transmitting the electrical energy from where it is made to where it is used, and a chapter each of the economical aspects, and the organization and operation of hydroelectric power plants.

SIX HUNDRED AND FOUR YEARS FOR TWENTY-SIX MEN.

The organization of building 16 includes S. S. Forster, twenty-six years; G. G. Maier, twenty-eight years; R. Smith, twenty-nine years; Charles Staver, thirty years; F. W. Schutte, thirty-

one years; J. Spence, twenty-eight years; G. Stump, sixteen years; H. Franken, twenty-four years; J. McChesney, thirty years; William Russ, twenty years; H. W. Swanker, thirty-one years; S. Griffiths, eighteen years; J. Mulvey, twenty-three years; C. Collins, thirty years; F. Mattock, twenty-four years; J. Williams, eighteen years; N. Armstrong, eighteen years; S. Houcks, twenty-four years; J. Bunk, thirty years; J. Sibel, seventeen year; J. Hill, twenty-nine years; F. Geddes, twenty-eight years; Fred R. Waldstedt, fifteen years; H. Heinbuch, twenty-six years; E. Schaddegg, nine years; F. McHale, two years.

Total service of these twenty-six men 604 years.

In addition to the thirteen men listed above who have served twenty-five years and longer there are forty-five others who are also members of the Quarter Century Club, as follows:

QUARTER CENTURY MEMBERS.

W. S. Ashdown, J. W. Barnes, G. Bathrick, William H. Benning, George Bernhard, John H. Boyle, James Byrne, James O'Connell, E. C. Coons, A. Dugglin, F. J. Ernst, L. Flanigan, Gustave Folgs, Thomas Foley.

Adolf Gehroldt, C. F. Gerling, F. W. Gerling, J. H. B. Gifford, E. Hagin, William H. Haley, John F. Hennessey, Joseph Jablonski, Robert F. Jutton, Charles Kayko, Fred Krug, Robert E. Kurth, Charles E. Luckhurst, George McCulley, John H. McMahon, Herman Macholz, William M. Mead.

August Neuber, William F. Pirk, John M. Robertson, Andrew Rudesheim, Phillip Sauter, George Schiele, John O. Sherman, Ben Sinnenberg, J. W. Sproat, Charles B. Stevens, F. B. Van Vranken, Valentine Wallburgg, J. H. Wilkie, William Wintle.

CHAPTER IV

TITAN—THE FIRST POWER GIANT

OVER SIXTY OF THE ORIGINAL BUILDERS STILL ENGAGED IN STEAM TURBINE WORK.

Over 60 men are working today in the General Electric works at Schenectady who have helped bring about the wonderful developments which revolutionized the world's method of making electricity.

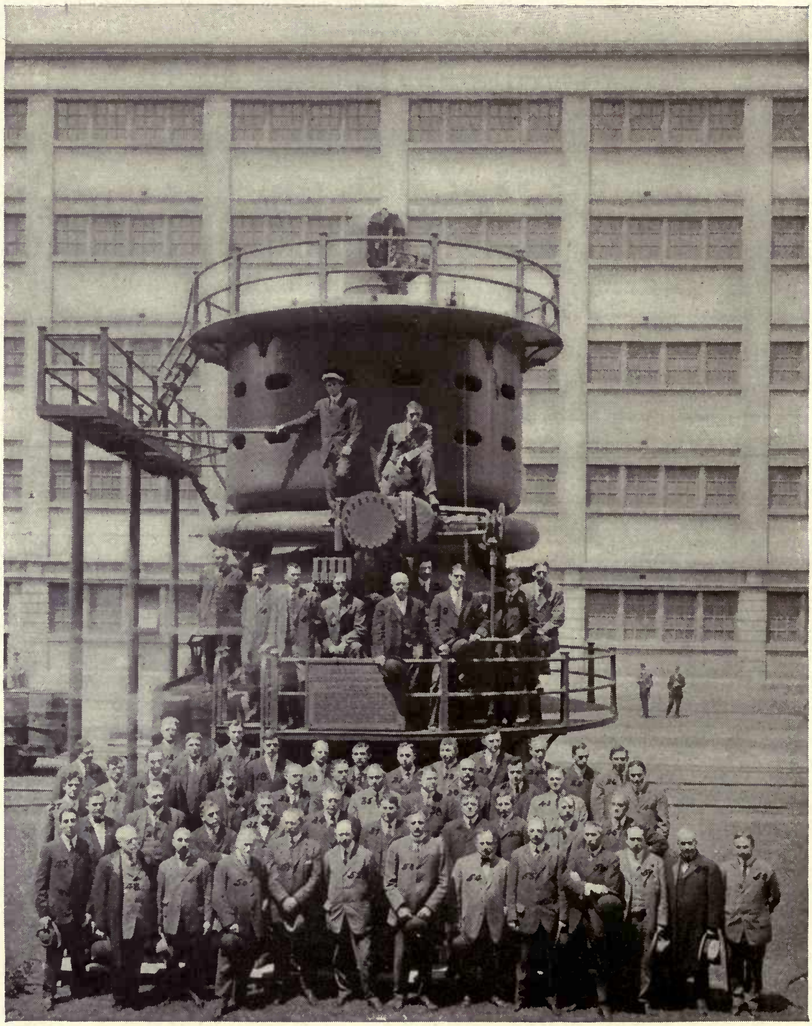
Millions of people use electricity generated by steam turbines, thousands of men in Schenectady help build these turbines today, a hundred or more are continually improving their design and construction, and more than 60 men now here, shared in the terrific task of designing and building the first great turbine—the one which made history.

In 1629 an Italian named Branca succeeded in making a wheel turn around by directing steam against it from a boiling kettle. No doubt Mr. Branca had seen hundreds of windmills and water wheels and it is quite possible that he reasoned this way: "If wind and water will blow wheels around and make power, why couldn't steam also blow wheels around and make power?"

But Branca had no broad-visioned corporation able to finance elaborate experiments, nor did he have any commercial organization to market his inventions and make it useful to mankind. So the steam turbine as a power producer was abandoned —forgotten—the science lapsed—you might say it became one of the "Lost Arts." Just how long the steam turbine continued to be a lost art is strikingly illustrated in many reference books. Let us examine just two.

WEBSTER'S DEFINITION.

Webster's Unabridged Dictionary in 1884 said that a turbine was "A horizontal waterwheel," and the Century Dictionary even as late as 1891 defined a turbine as "A waterwheel." Thus, it is proved that the work of Branca can properly be classed as "Lost Arts."



" Titan " The First Power Giant, now stands as a monument in the main avenue of the Works.

The steam engine makes a strange chapter in history. It immediately benefited mankind when it was applied to factories and made possible our steam locomotives and steamboats, but though the engine succeeded the first turbines, it was destined itself to be superceded by turbines from building No. 60. So there have been two great engineering revolutions since the days of Branca—one in England which brought in the steam engine and made it universally used throughout the civilized world, and the other in Schenectady, which developed the steam turbine so that it is rapidly displacing the engine just as the engine itself had formerly displaced the dull drudgery of physical labor for countless millions of workers.

And now we are coming back to Schenectady, where a great historical event took place in 1902—for here the great modern steam turbine was born—making the renaissance of the turbine as a power producer.

Now the modern electric railway systems, the five-day trans-Atlantic steamers, the biggest dreadnoughts of the United States navy, thousands of factories and practically all of the lighting and street railway plants in our great cities use Schenectady steam turbines as a source of power.

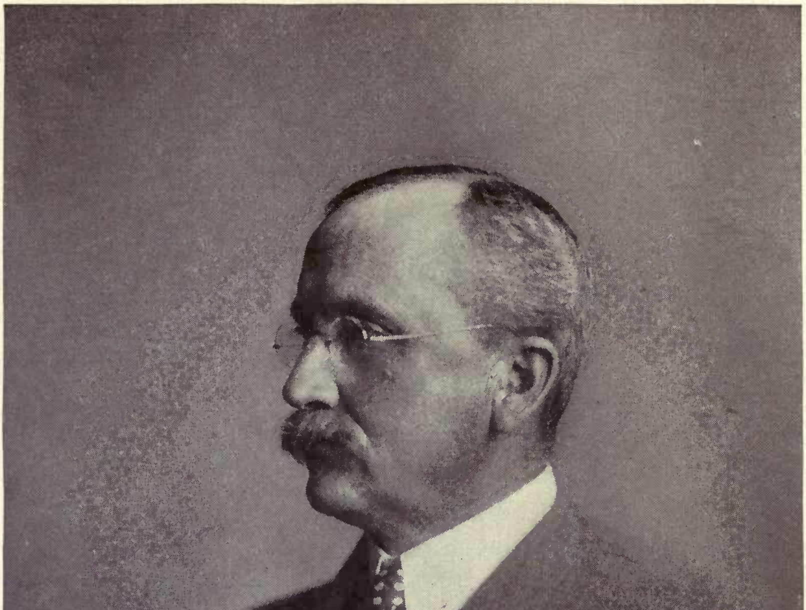
And the great event which made all these things possible was the building of the first large Curtis turbine here in Schenectady.

Here he was born—the father of a new race of giants. For, if the locomotive engineer calls his engine "she" and if the gunner on a United States battleship calls his 12-inch gun "Long Tom," why should not the electrical engineers and mechanics call the turbine-generators, "He," or even "Our Titan."

FATHERING THE GIANT.

When built in 1902-3, he was the largest turbine in the world. He had the power of 6,660 horses, 5,000 kilowatts. Up to that time 500 kilowatts had been the largest Curtis turbine. Think of it! A leap from 500 to 5,000, past achievements multiplied by 10—all in a single master stroke!

Daring work it was at that time to conceive and build a turbine 10 times greater than the greatest in America. It was a bold step away from the conventional—for most industries grow step by step. Absolutely original was the work of designing and



Mr. W. L. R. Emmet, Consulting Engineer, who "stood by" the turbine in the early experimental days and whose faith inspired the successful building of "Titan" the first power giant.

building this Titan; yet perhaps it required as much courage and originality on the part of the man who adopted him before he was born—who bought the young Titan before he was built. It was Samuel Insul of Chicago—the one man in the United States who had the commercial faith and genius to match the engineering faith and genius of W. L. R. Emmet, who was consulting engineer on the design. In fact The Iron Age in an article July 26, 1896, spoke of this turbine as the "Emmet-Curtis" turbine.

BRAINS AND HARD WORK.

There were many who said, "It cannot be done." Failure after failure was recorded; hundreds of experiments, heart breaking disappointments; sleepless nights; wrecks even, but luckily not a man was hurt.

On that great birthday was the beginning of a new era in the electrical and industrial world. It was a leap in science that made renown, fortune and history—the greatest step in power plant progress since James Watt invented the steam engine, a century and a half ago.

The young giant was sent to Chicago and for six years, night and day he did more work than was expected of him. His toil was equivalent to the toil of 20,000 horses working in three eight hour shifts. And since one horse power equals 10 men's power, he really turned as many wheels and lifted as many burdens as could 200,000 men—and he did this for six years! Nor was he worn out—nor nearly worn out.

But in the meantime the men building No. 60 had built even greater turbines, so the original young giant was brought back to Schenectady—and you might say he was pensioned, as a faithful old horse is often turned out into a green pasture to end his days in peace and quiet.

And as you walk up the main avenue of the Schenectady works —surrounded by throbbing workshops—you will see him where he now stands—a monument, commemorating the birth of the great turbine industry. This old machine, old in point of progress, yet young in point of years, has been an inspiration to the thousands who view him daily and who know the story of his wonderful career, and the heroic labor from which he was born.

Now, 17 years after the turbine was built, let us see how many

of the men who had a share in building him are still to be found in the General Electric organization. Let us begin with the shops —the men who actually built him with their own hands:

JACK STARBARD.

Here is Jack Starbard, machinist on the step bearings. Jack is now in building No. 60, as is Andrew Schairer, who was at that time foreman of lagging. Vine Turnbull was at that time assembly machinist, while Jack Fink, Luke Ralyea and Leo Kirk were machinists on the governor work. Tom McGraw is glad to say he machined the valve parts on the old turbine, and William Lasher did much heavy work on the turbine wheels with his boring mill. Mathew Murray did the machine work connected with the steam packing and Nichols Jeffries feels pleased every time he looks up at the old turbine and sees the machine work which he did on it.

Others were Paul Snyder, machinist on the emergency governor; Charles Sleeter, machinist on the governor testing; Clarence Young, machinist on the needle valves; McGrehan, assistant foreman of the bucket department; John McGuire, machinist on the steam piping; William Briggs, assemblyman on the governor; John Dillon, machinist on the controlling valves; Barney Linda, machinist on throttle valves; Jacob Myers, in charge of the machine tools; Thomas Broderick is the man who trimmed the shaft down to dimensions, directed by Tom Keating, foreman of shaft turning.

In those old days Thomas Hollman was night foreman, Henry Sleeter was assistant foreman in the small tools department and Fred Wineburg was foreman of the bucket department; Robert Barhyt was then foreman of lathes, and is now foreman of all the detail machine work in building No. 60. And George Wintle, too has many vivid recollections of those trying days when men sweat blood. He is still foreman of the heavy machine tools.

William M. Madigan, now general foreman of shop No. 60, divides honors with C. Mortensen, whom he succeeded as general foreman. These men can relate stories of the inadequacy of the machine tools in those days, and the "stunts" or expedients which were devised to turn out the work of unprecedented size and

shape. Henry Geisenhauer had charge of the experimental work in the shop.

J. T. Flickenger, assistant, and H. Farquhar, superintendent, had some job on their hands in providing unexpectedly hundreds of things which were needed, for when a thing is 10 times bigger than anything else has been, there are many new problems which must be met and solved promptly and accurately.

MECHANICAL STRESS.

David C. Garroway did most of the stress calculations on the mechanical end of the turbine, and he was assisted by Alex. T. Gray, who did much of the drafting and made the layouts. J. A. Dolley, B. A. Garrett and J. L. Hoose were also in the drafting room on this job. Mr. Garroway figured out that if the rotor of the old turbine would revolve at the rated speed while lying on its side, that it would roll to Chicago in between three and four hours; but now some of the velocities are five miles a minute.

THE DESIGNERS.

The drafting men were working out the details of the "creative sketches," and "mental pictures" furnished by the designing engineers, both the electrical and mechanical. On the steam end of it E. D. Dickinson was a specialist on carbon packing and electrically operated valves, and later assisted as designing engineer in charge of installation.

August Kruesi was one of the designing engineers also, having perfected the governor with which to control the rotating velocity of the turbine.

Oscar Junggren was chief designing engineer, collaborating with W. L. R. Emmet, the chief engineer of the turbine. In shop, drafting room and office alike, Mr. Emmet is acknowledged as the one man above all others who had the deep faith to put through the record-breaking enterprise.

Dr. Charles P. Steinmetz, the chief consulting engineer, assisted by Dr. E. J. Berg, contributed toward the design by theoretical investigations. When Dr. Steinmetz was shown the proposed electric generator design, he merely said: "That will work"—and it did!

H. G. Reist had general supervision of the mechanical features of the generator design and W. J. Foster of the electrical. They

made the calculations and original sketches for that unique size and type of generator.

E. Knowlton and W. E. Holcombe assisted Mr. Foster as designing engineers, as did also George Monson, who made many of the calculations and estimates.

Electrical drafting was done by A. B. Frost, who is now in charge of the drafting room at Erie; C. S. Raymond, then a draftsman, but now engineer in the turbine generator department; and C. H. Chambers, then an inspector and now foreman of the drafting room in the turbine generator department.

Working from the electrical designs of these men, Henry May, the assistant foreman of electrical winding; A. Putnam, coil maker, and J. Griesler, who did coil insulating, installed the copper in the new, strange machine.

Langdon Gibson, assisted by H. W. Philbrook and L. Elting, handled the production problems. A. R. Dodge conducted, day and night, the invaluable experiments with nozzles and buckets, and he also had charge of the machine at Chicago for several months.

E. F. Collins tested it, and in the days of construction, F. W. Taylor, F. M. King and E. McFarland remember many strenuous days and nights. And M. C. Fitzgerald recalls how he broke two freight cars and finally had to have a special train in order to get the great machine to Chicago. But now he smiles at his old troubles—because these days he is shipping turbines with ten times the power.

A comparative stranger in Schenectady saw the great turbine monument for the first time on one of his trips through the works and was much impressed, and after hearing the story, exclaimed:

"Why, the story of this old giant should have been written by a master; it is too bad that John Milton died before he saw this impressive picture and learned the history."

That afternoon he took a train for New York, his imagination fired by the wonderful achievement of "the giant Titan" and his descendants, and going down on the train he wrote the following:

TITAN'S BIOGRAPHY

"Conceived of master intellect, with toil, untiring research and experiment; moulded and shaped in mammoth works; fashioned of copper from the west, of cotton from the south, of silk and mica

from far distant shores, he was born encased in molten northern iron and steel. Dowered with the gold of those with faith, with the wealth of scores of minds, with the skill and strength of near a thousand arms; cradled near clouds of steam, swung high by giant hoist in Vulcan's lofty forge; nurtured with scalding steam from boiling breasts of ten seething furnaces; his lullaby the shriek of tortured steel, and sharp staccato strokes of countless tools; watched o'er by anxious eyes, and worked upon by willing hands oft cut and burned; growing apace as brain and brawn dovetailed to build great bulk; trained in the arts of Titan; taught self-control which engineers call "governry"; improved, developed, criticized, until he was pronounced "completed" in Schenectady!

"He was the first of a new race—no natural progenitors; a type unique, a monster polygenous and strange; he had ten times the power of pigmies that had gone before and which had been christened "turbine," same as he.

"Then Insull came, electric Aladdin of the west, who, seeing, sensed the vision of his future worth and claimed him for his own; and so, departing from the city of his birth, his creators and tutors all bade him adieu, but brothers, friends, sweethearts or chums he never knew; 'twas thus he journeyed west, glowing, within his heart the ambition to benefit mankind.

"Launched well, upon his life's career, by trusted crew of those in his strange infancy he knew, for nigh ten years this Titan spun the warp and woof of mid-west industry. Two hundred thousand men from dull drudgery he did emancipate; until in his strange image his sons were born—so great that they out-Titaned Titan!

"Proud to see his offspring mightier far than he, and knowing the sun of his industrial supremacy was set, he yielded up his post to one of his young stalwart sons for whom he's shown the way, and journeyed back to where he first saw day, forsaking strenuous toil for task more fitting honored veteran and sage. And here, in his new dignity, he will outlive the century which gave him birth; in his new work a teacher of mankind. Illustrious example inspiring earnest youth, nor less a stimulus to flagging steps of more mature. Upon his throne he sits in silhouette against the sky, a monument, a sphinx-like paradox of silent eloquence.

L'ENVOI.

Nobler none throughout the ages
He will stand with old-world sages.
Ye who inspiration need
View his frame with thoughtful heed—
Then speed ye, for the hour grows late,
Idle not—let laggards wait."

AN INTERESTING STORY OF TITAN'S FIRST JOURNEY

A Reminiscence by A. J. Gifford
Manager, Transportation Dept.

One of the most interesting features connected with the shipment of the 5,000 kilowatt Turbine for the Chicago Edison Company was omitted from your very interesting account of it, it was the circumstance connected with its shipment to Chicago.

As I recall the circumstance, this Turbine was to be delivered in Chicago by a certain date either by contract or promise. Some of its parts were so large and cumbersome that there was some doubts in the minds of the New York Central Railroad as to whether it would clear the low points in their road. We consulted the official guide and instructions and found that it would clear by narrow margin beyond question. We loaded large and heavy pieces of the Turbine on our own specially constructed cars which were built as low as possible for any cars to be built, 3 ft. 2 in. from top of rail, and altogether employed about fifteen cars. We offered this shipment to the New York Central Railroad in due course, and they held it awaiting the advice of their General Superintendent in New York, for approximately a week or ten days, as to whether they could handle it, notwithstanding our efforts to convince them that the Turbine must be in Chicago by a certain day which could have been normally accomplished had they moved the shipment when we delivered it to them.

We finally saw that owing to this delay that something drastic must be done in order to get the Turbine in Chicago by the day specified, after they finally agreed to accept it for shipment.

The Commercial Department authorized the arrangements to be made to move it special which would allow it to reach Chicago on the day specified.

At that time they agreed to move these fifteen cars special from Schenectady to Chicago for $1,000.00, in addition to the regular freight charges which made it possible for it to reach Chicago in time.

Some months after we met Mr. A. H. Smith, who at that time was General Superintendent of the New York Central, but now president of the road, and spoke of the injustice of the $1,000.00 charge for extra service on this shipment, under the circumstances.

We related to him the whole history of the case, and he then and there admitted it was an unjust charge having all the facts in view of their withholding the shipment so long before they would accept it for movement and that he would refund the amount paid for it, special movement ($1,000), which he did.

CHAPTER V

TURBINES OF TODAY

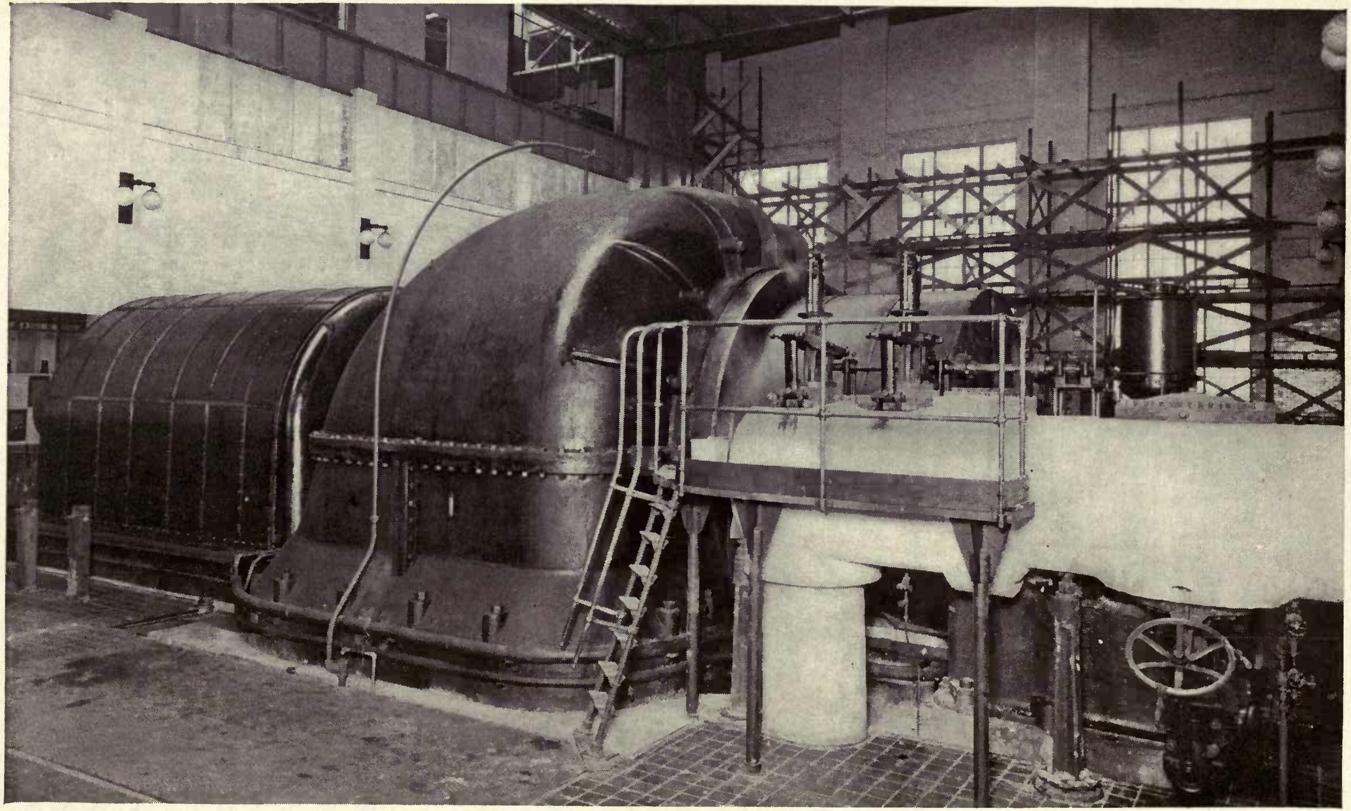
TURBINES OF TODAY TEN TIMES MORE POWERFUL THAN THE FIRST GREAT ONE—BUILDING SIXTY LITERALLY HOME OF MANY WONDERS—WORK IN MAMMOTH SHOP DESCRIBED—FIFTEEN HUNDRED MACHINISTS EMPLOYED

The story of the turbines being built today is no less interesting than the history of the first great turbine—the father of them all. He had the power of delivering continually the equivalent of 6,666 horses—electrical engineers would say "5,000 kilowatt." Although it was a marvelous feat to build this machine 17 years ago, today one says "Only 5,000 kilowatts—only 6,666 horsepower." For there are today many turbines any one of which is supplying seven times as much power as did the first of their tribe; and some of them supply ten times as much.

From Boston, New York, and Cuba, to Alaska, California and the Philippines, even in South Africa, Japan, China and Europe—everywhere, are found Schenectady turbines lighting the streets and homes of the world and turning the wheels of the industrial plants in arctic and tropic lands alike.

Today you could walk down one of the aisles in building No. 60 and see Walter Moat operate one of the biggest boring mills in the world, as he trims down the gigantic castings which go to make up the turbines. The boring mill platform on which he stands has traveled 13,000 miles in the nine years that he has had charge of its operation. Nobody knows how many tons of metal he has removed from the rough castings. You do not know which to marvel at the most, the machine that he operates or the machine that he is building. Then you try to speculate on the work which will be done for American industry by the giant 45,000 kilowatt turbine with the power of 60,000 horses, 600,000 men.

It is hard to appreciate this amount of power. If it were applied to lighting it would illuminate a street as wide as Broadway reaching around the earth.



This steam turbine built in Building No. 60 is now working in the Detroit Edison's Co. Power House. It is rated 45,000 kw, which means that every minute in the day it can deliver 60,000 H. P. Thus this single machine can create as much energy as would equal the power of 180,000 horses working in three eight-hour shifts.

OPERATE STREET CARS IN CITIES.

Applied to power in transportation, it could operate all the street cars in 10 or 12 cities each the size of Schenectady.

Applied to power of a destructive nature, if this were used in crushing and grinding machines, it could chew up the Washington monument in a few hours and grind it into sand before another sunrise; applied to numerous metal saws, it would be but a trifling job to saw all the steel in the Woolworth building into small pieces.

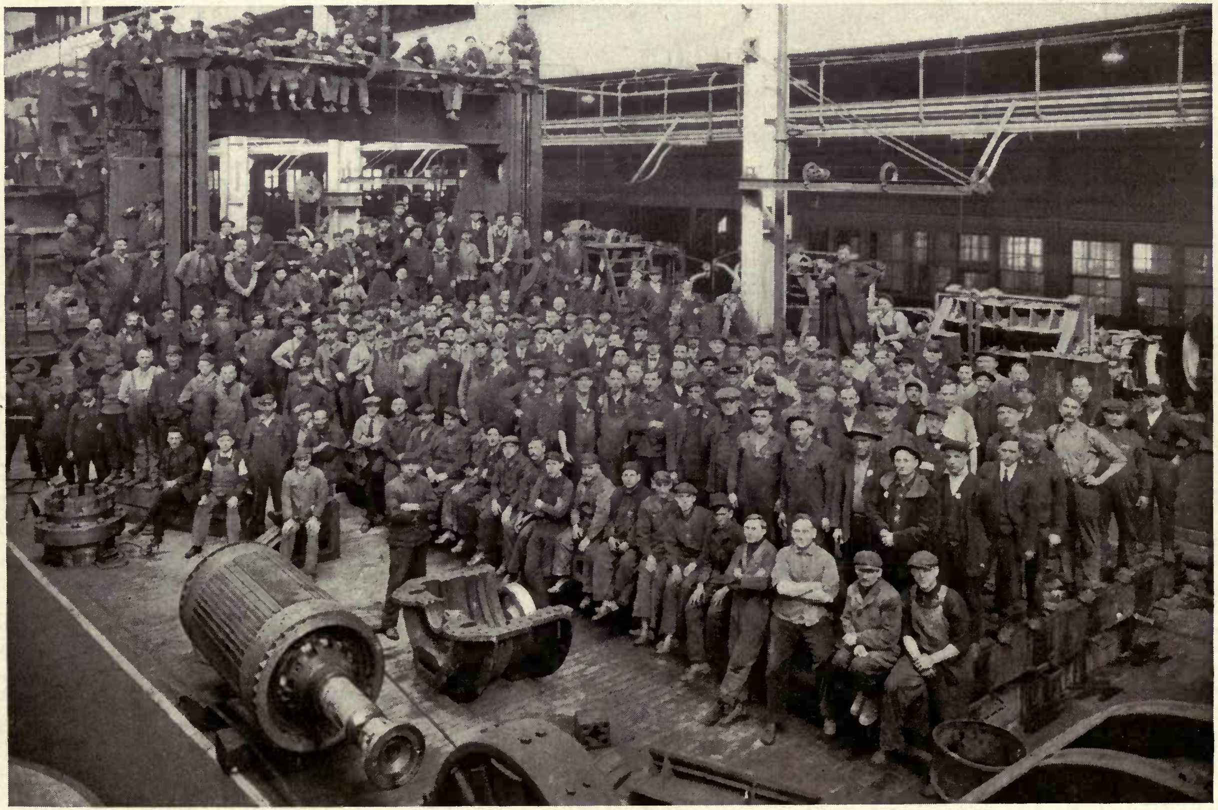
Applying this power of the giant to heat through electric arcs, it could melt down the Eiffel tower and send it crashing into the streets of Paris in a quarter of an hour!

In a walk down the aisle of building No. 60 one can read these inscriptions on the machines which are now in process of construction: Scranton, 7,500 kw.; National Tube, 10,000 kw.; Building No. 61, power house, 10,000 kw.; Pacific Gas, 15,000 kw.; Toledo, 20,000 kw.; Chicago, 30,000 kw.; Boston Elevated, 35,000 kw.; American International Shipping, 6,000 kw.; Ford Motors, 12,500 kw.; Louisville, 15,000 kw.; Maryland, 11,000 kw.; Philadelphia, No. 4 and No. 5, 30,000 kw. each; Detroit, No. 1 and No. 2, 30,000 each. Those who have visited the cities can picture them in their minds and can in their imaginations take a journey over the length and breadth of this country as they walk down the aisle of building No. 60.

One turbine made in building No. 60 ran 11 months, three weeks, six and one-half days in active service without a single stop; and it was only stopped then, to clean some water pipes. Owing to its rotary motion and the perfection of the governor, the speed of rotation can be most delicately regulated, a feature greatly appreciated by power plant engineers who pump electricity into the same wires from several turbine-generators at the same time.

The turbine saves coal. For every ton of coal required to to develop power in one of the latest turbine plants, a reciprocating engine plant of the same power would need practically 70 per cent more.

There are several reasons why the turbine makes more electricity out of a ton of coal than the engines did. Any one of these reasons is enough to make a buyer prefer a turbine, but all



The biggest planer in the works, if not in the world was constructed this Spring in Building No. 60. About 200 machinists have posed on this gigantic tool. This picture will be a good souvenir of "The Bunch I worked with during the war."

of these together simply allowed the turbine to run away with the market, in big power plants.

The turbine extracts more of the heat out of the steam than the engines did. The steam enters the latest turbines at a temperature of about 656 degrees F., or hot enough to melt lead. In most large steam engines it entered generally at not over 380 degrees. Since the engines and turbines are both classed as "heat engines," you can see that the more heat you put into a turbine, the more power is available.

PRESSURE OF TWO HUNDRED AND FIFTY POUNDS.

The steam is driven into the turbines at a pressure often as high as 250 pounds per square inch—the big Interborough engines in New York, which were considered models, used steam at only 180 pounds or thereabouts. It is hard to describe the pressure of the steam after it comes out of the turbine because it is less than atmospheric pressure. Engineers call it "a 29-inch vacuum." And this calls to mind the fact that the exhaust steam is sucked out of the turbines by a condenser, which also turns the steam back into water. It is an interesting fact that the pressure inside of the turbine changes rapidly but systematically from boiler pressure to vacuum pressure, and at about the middle of the turbine the pressure is almost exactly equal to that of the outside air. A turbine which exhausts into a condenser with a 29-inch vacuum gives twice as much power as if it exhausted the steam out into the atmosphere.

REASON FOR EFFICIENCY.

The great output and high efficiency of these turbines is partly due to the fact that the exhaust steam outlet can be very large, thus permitting the steam to expand to 200 times its original volume before it leaves the turbine. The farther this expansion is carried, the greater the energy extracted from the steam, for as the steam expands it pushes round the wheels inside the turbine. There is a turbine being built now in building No. 60 with 23 wheels; that means that the steam dashes against 23 different sets of buckets between the time it enters one end and is shot out of the other end, 1-25 of a second later. In order to accommodate this great expansion, the exhaust steam "pipes" of a 45,000

Another view of the " Grand Canyon " of Schenectady where the giant turbines are manufactured in Building No. 60.

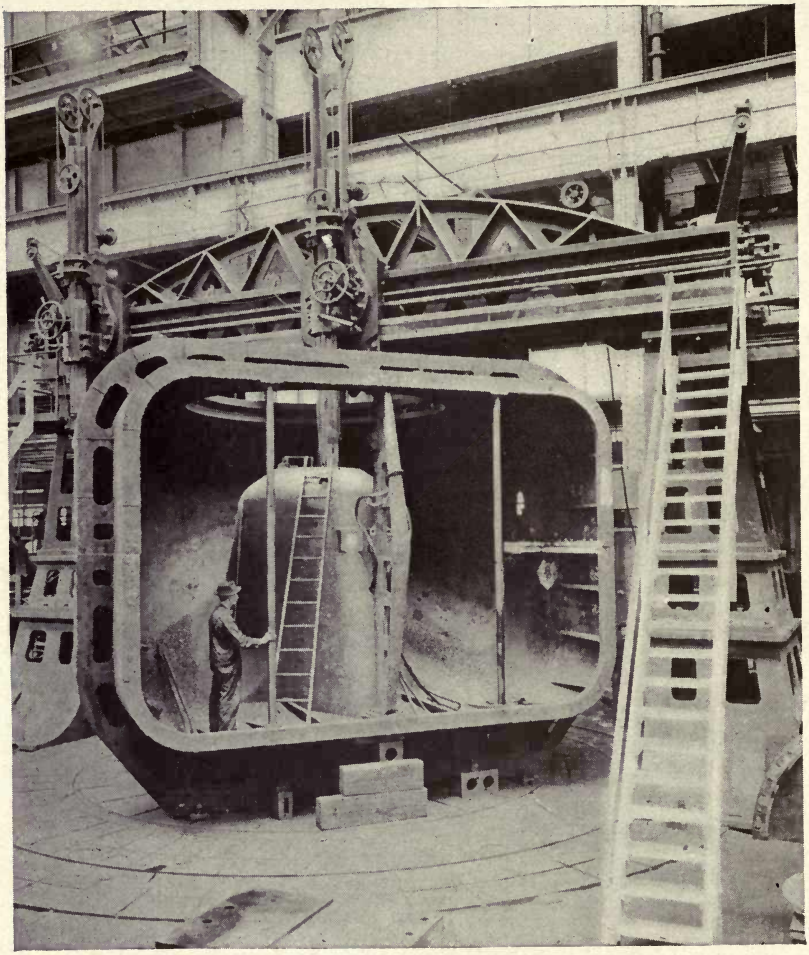
kilowatt turbine are not measured in inches, as are the exhaust steam pipes of engines, but are measured in feet; and the big 45,000 machine now working in Detroit has an exhaust steam passage 12 feet wide and 18 feet long. It would hold six 7-passenger automobiles double decked, three side by side and room to spare. This space is filled with moving steam—little more than a cool vapor—steam that would not boil an egg or burn a baby. In its best power plants this steam has a temperature of 79° F. or 18° cooler than human blood.

The wonderful transformation worked by the turbine is illustrated by the fact that this cool mist, 1-25 of a second earlier war roaring into the turbine at a pressure of 250 pounds per square inch and at a temperature of 656 degrees F.—hot enough to melt lead.

The designers and builders of these turbines sought long for a combination of metals which, without appreciable wear, would resist the impact of the jets of super-heated steam traveling almost 45 miles a minute, or 40 times faster than the Empire State Express. Hundreds of experiments were made in the factory and in service, to ascertain the precise shape and temper for the metal in the buckets. A hardness was desired which would not be too brittle under pressure; a kind of hardness which would not warp when subjected to the intense temperature of superheated steam—yet tough enough not to be pulled apart, or ripped from the wheel by centrifugal force.

THE SUPREME TEST.

They found it finally, but some strange experiments were necessary first. One turbine was placed in a pit and deliberately permitted to destroy itself. They disconnected the governor and ran it at a frightful speed in order to see what would break first. In another instance, one large wheel fully equipped with buckets was turned by a 500 horse-power motor faster and faster inside of a turbine without any steam, until it was turning at double its rated speed. A great deal of heat was generated due to friction with the air inside the turbine, and when the turbine was opened it was found that while nothing had been broken, bent, loosened, or warped out of shape, that the buckets had been turned a bright blue, due to the heat generated by friction of the air. In



An unusual view of the inside of the exhaust steam passage of a great steam turbine. In the chapter on "Giles's Aviators" is a time-exposure photograph of one of these casings rotating on a big boring mill.

fact it had put a fine temper on every blade in the wheel. This brings out the curious truth that steam at 656 degrees F. would really have served to "cool" the buckets. It is hard to conceive how anything could be cooled by such hot steam, but these are the kind of problems dealt with by the men in building No. 60.

In this building there are 35 overhead electric cranes, about 1,000 motor driven tools employing 2,500 motors with an aggregate of about 10,000 horse-power. Nearly a score of these tools are portable, that is they can be lifted up by the cranes and set down any where. Large iron floors with a total of almost 30,000 square feet are used for assembling the turbines, and when portable tools are lowered down on the iron floor by means of a crane, they are perfectly level and ready for work with mathematical accuracy.

Here is the largest planer in the works, 18 feet between housings; and other planers as small as three feet. Here also is one of the largest boring mills in the world, 40 feet between housings, and the smallest in the shop is two feet. The 40 foot mill is operated by Walter Moat and Frank Hall.

The lathes, operated by George Dewey, vary from the 96 inch to 8 inches swing, and the shapers from 26 inches to 18 inches stroke.

There are six double horizontal milling machines of special make, the largest operated by Fred O'Brien, and many radial-drill presses, the largest with a 12-foot swing, is operated by Elmer Johannason.

It is stated that building No. 60 is the only shop in the world in which all of the machines have individual motor drive without an exception, and it contains not a shaft or counter shaft.

BUILDING'S MAGNITUDE.

To get an idea of its magnitude you should know that it has 500,000 square feet of floor space, being over 800 feet long and 300 feet wide, with four galleries and two mezzanine floors. It has over 100 miles of wire in it, and 10 miles of steam pipes. There are 45,000 square feet of glass in the 470 windows and 24 doors; and 109,000 square feet in the skylights. The building contains in the structure 8,400 tons of steel and 4,000,000 bricks.

Another view of the grand canyon of Schenectady in Building No. 60.

It contains 6,888 sprinkler heads, nearly a mile of fire hose and 130 fire buckets.

In order to run the turbine department the following organization is necessary:

One general foreman and assistant, 10 foremen, 20 assistant foremen, 16 gang bosses, 24 inspectors, 29 stock and tool room keepers, 7 production men, 71 clerks, 3 messengers, 59 cranemen, 96 helpers and crane followers; 1 oiler and belt lacer; 18 sweepers and chip wheelers, 3 elevator men, 1 washroom attendant, 2 tool grinders and saw filers, 22 men repairing machinery and tools, 4 storage battery car operators, 1 foreman looking after tools and fixtures, and 2 instructors on boring mills.

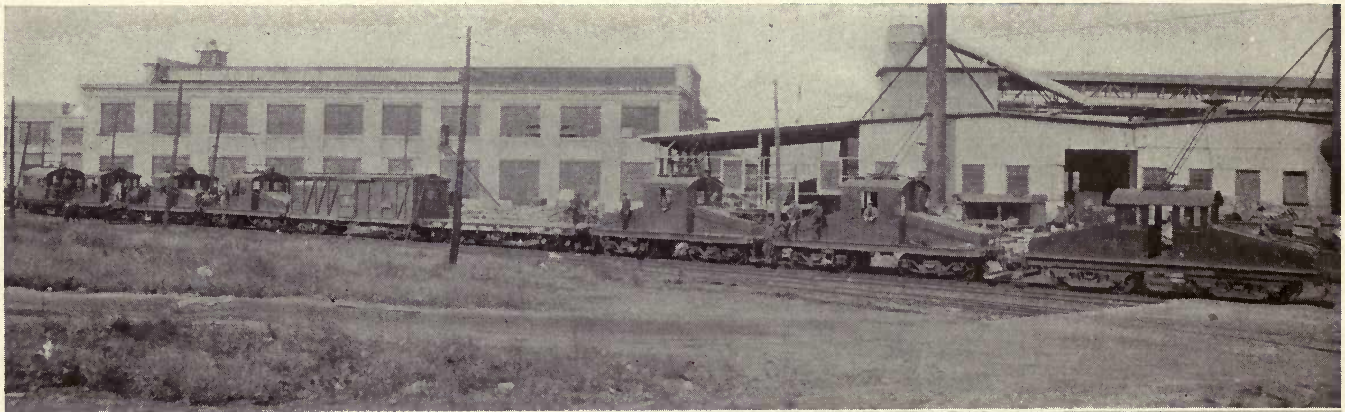
Thirty-nine of the employees are girls. In addition to all these there are 1,500 machinists working in this building in the turbine department alone.

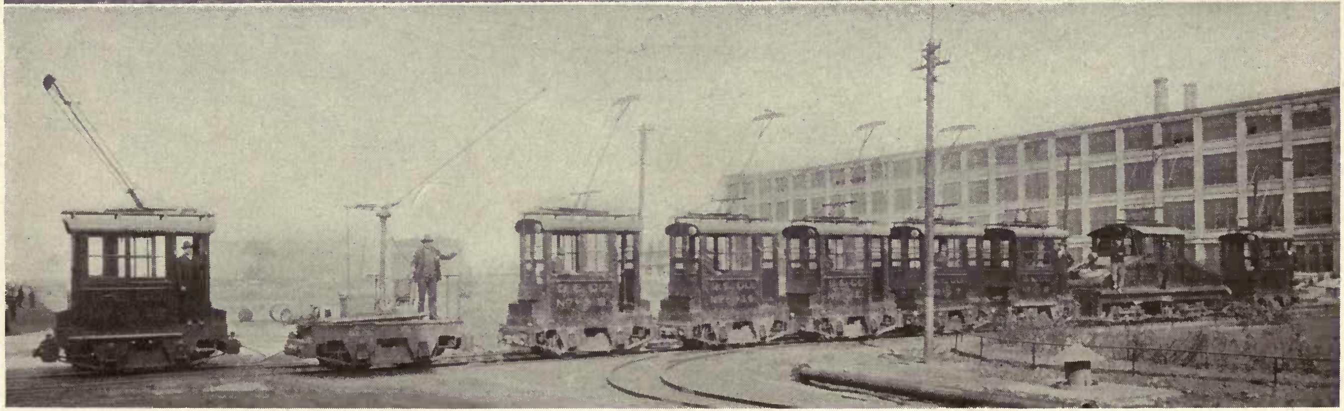
The organization of the steam turbine department, building No. 60, follows:

William Madigan, F. Smith, G. Wintle, T. Keating, W. Herron, D. Maynard, S. Schultz, E. Sheehan, A. P. Huffmire, W. Van Valkenburg, J. Short, V. Turnbull, J. Herron, F. Lucier, J. G. F. Reilly, C. Stoddard, W. H. Hunter, G. Hickok, T. Broderick, A. Jackson, J. Kidd, R. McKay, C. Schlectiger, H. Grovenstein, H. Boyd, E. Jacobs, J. Frey, R. Barhydt, J. Turner, L. Kirk, T. McGrath, J. J. Murphy, W. Clegg, H. I. Haker, C. D. Genning, W. B. Wilkie, C. D. Brower, W. F. Van Hoesen, E. Faulkner and J. S. Bailey, C. Dean, F. L. Roberts, W. Turnbull, J. Hickey, E. B. Warner, J. Vernon, C. Sweeney, G. Clark, J. Fink, W. Bridges, G. Knox, J. La Point, J. Hall, E. Miehl, H. J. Mildren, D. C. Peters, F. Phillips, R. E. Hulse, S. McGiviny, J. Loy, R. Stearns, F. Ottman, C. Durham, W. K. Voorhees, P. Volkert, J. Finnigan, G. E. Alexander, F. Sutton, W. Jansen, I. Winne, A. Van Wormer, A. G. Fagel, G. Weiber, G. Osterhout, C. Glover, E. Groff, W. Walters, B. Barney, W. Davenport, B. Jesmain, H. S. Forte, E. Langlois, M. Hulett, F. Sweet, B. Hand, D. C. Houck, H. H. Walsh, F. Lenhardt, B. Cortwright, H. J. Burchard, G. H. Guardineer, F. Taylor, F. Sexton, B. Ott, H. Frederick, R. Deans, L. S. Hannigan, W. Fitzpatrick, W. A. Fountain, T. Williams, F. B. Snyder, S. Bryan, C. C. Ward, Miss E. Spencer, H. Schryver, R. Seldridge,

Big steam turbines being tested in Building No. 60. Many visitors are impressed with the number of *steam* pipes in an *electric* manufacturing company.

C. G. Smith, E. VanDerzee, W. Harris, A. C. Topp, Miss O. Thayer, Samuel Mark, P. Biondo, I. Bullock, W. R. Higgins, Mrs. Kline, H. Hershenhorn, Mrs. D. E. Seeley, Miss M. Cronover, Miss I. Fabosky, Miss R. Silverman, Miss E. Holton, Mrs. M. Archambeault, Miss A. Senworth, Mrs. I R. Brown, Miss K. Feight, Mrs. M. St. Pierre, Miss L. Monz, Miss E. Rector, Miss M. Thornton, Mrs. M. T. Dunham, S. Dzikowski, J. Baranowiski, B. E. Cohen, K. P. Barnard, Miss L. Mason, Miss E. Barnett, E. Conklin, E. Smith, Miss M. Springer, Miss L. Cohen, Miss E. M. Dunn, Miss E. Quisgaard, Miss C. Lehman, Mrs. H. Fraser, Miss M. Riley, Mrs. A. Settle, Miss C. Dente, Miss O. Murray, T. Hawley, Miss L. F. Croissant, H. C. Paige, G. Grey, V. Baker, H. R. Hunt, Mrs. M. McGinnis, M. Mahaney, Miss A. Hennessey, Miss A. Huffmire, Miss H. Leschke, Miss M. Kennedy, Miss E. Tidball, Miss R. Polikoff, Miss A. Yunker, J. L. Kennedy, Miss M. Stevens, A. Shock, W. Walker, H. Kohlmeier, E. Vrooman, A. Stoddard, J. Fitzpatrick, R. Roberts, J. L'Amelio, G. Wintle, J. Madgett, E. Conine, G. H. Douglas, J. F. Barcher, L. Sterling, M. Best, R. Moffett, E. Gunn, S. Slater and J. Blackburn.





Top.—Fleet of seven standard gauge electric locomotives and standard G. E. box and flat cars.
Below.—A few of the narrow gauge electric locomotives. Formerly they were not enclosed, but all appeared like the second one. Note the "bow trolleys" which automatically reverse with change of direction from forward to backward.

CHAPTER VI

A GREAT FREIGHT TERMINAL

TWENTY-ONE LOCOMOTIVES, 800 FREIGHT CARS, 100 MILES OF TRACKS IN THE YARDS—30,000 CARS ARE MOVED MONTHLY UNDER THE MANAGEMENT OF EXPERTS WITH PRACTICAL OUTSIDE RAILROAD EXPERIENCES.

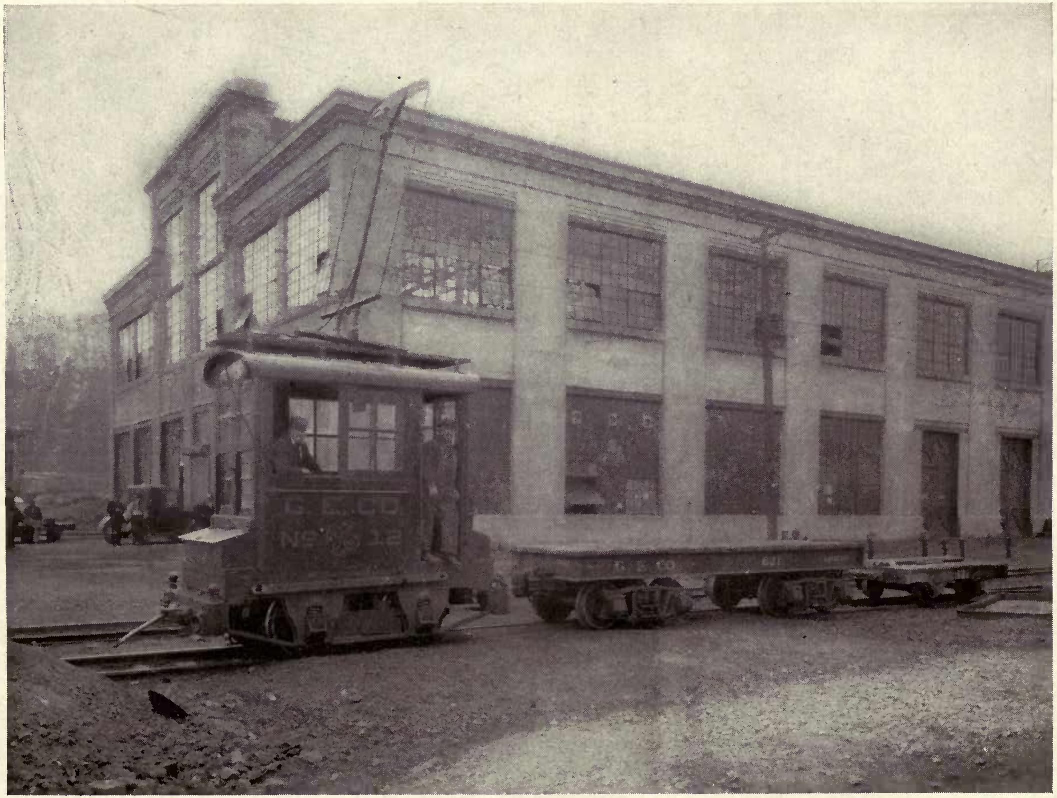
New Yorkers become accustomed to skyscrapers and do not appreciate them; the citizens of Buffalo under-estimate the wonders of Niagara Falls; those living on the seashore get less inspiration there than do those born inland; no one appreciates mountains so much as those who spent their early life on the prairie; and just so, a new arrival sees things in the General Electric factory at Schenectady—is impressed by them—perhaps more vividly than those who have been familiar with them day by day.

For instance, the remark is often made that the G. E. works is a city in itself because it has railways, motor busses, electric lights, a fire department, hospital, restaurant, schools, streets, lecture rooms, etc.

But, by mere chance, the scribe has gained a new impression—it is a great freight terminal. And the statement is literally true for the facilities are equivalent to those of a city of 250,000 population.

RAILROAD AND FREIGHT YARDS

With 21 switching and hauling locomotives and 800 freight cars, one could handle freight of an average city of 250,000 population. A city of this size would not have over 100 miles to track—but the internal freight service of the Schenectady works does have all this equipment and the equipment works. It works harder than it ever worked—not due to high speed, or hurry, or long hours, but due to the well-organized system, a harmonious machine composed of old time railroaders—a machine greased by good fellowship, made easier by good order, and made clean and comfortable by electric drive.



Photograph of the Narrow Gauge Electric Locomotive and the new narrow gauge car with a capacity of 40 tons. Note contrast between it and the older car. Formerly the locomotive engineers were exposed to the cold weather and the rain, but now they are protected.

LESS CARS MOVE MORE.

But the mere question of the number of cars moved,—that is not the whole story by any means. One is reminded of a hotel manager in New York City who said, "We are doing a splendid business. I know it because we burned 100 tons of coal yesterday." Some years later he got a new engineer and then he bragged how little coal he burned instead of how much. And just so, with the Schenectady works freight terminal—as surprising

View of Main Avenue showing (left to right) Buildings Nos. 52, 56, 60 and 64; "Titan's Monument," three trains of narrow gauge cars and Building No. 53 on the right.

as it may seem, 25 per cent less cars were moved in September, 1918, than were moved in September, 1916. And this was despite the fact that the company was manufacturing easily 30 per cent more material this year than two years ago before we entered the war.

HOW IT WAS ACCOMPLISHED.

Aside from the smoothly working organization, co-operating in a friendly spirit, there were other reasons for the fact that 30 per cent more tonnage was hauled by 25 per cent less cars. These other reasons were stated by James H. Rosenstock, the transpor-

tation manager, as some fundamental principles in railway operation.

Principle No. 1.—"Never deliver an empty car to a building when a full car is going to it."

Mr. Rosenstock says only 10 per cent of the cars now moved are empty and that, "It is a non-revenue tonnage, — moving empties is wasting time, money and equipment."

Principle No. 2.—"Never handle a car twice when you can do equally as well with one handling."

Principle No. 3.—"The same crew that hauls a car should deliver it with only one handling wherever possible."

Principle No. 4.—"Cars should be loaded to maximum capacity."

Mr. Rosenstock comments on this point that this may appear as a simple matter; but that the railroads of the United States have only recently fully realized the importance of heavy loading in relieving congestion and giving good service. He states that the present service in railroad management by direct routing and maximum loading, has reduced the number of cars at the terminals 33 per cent.

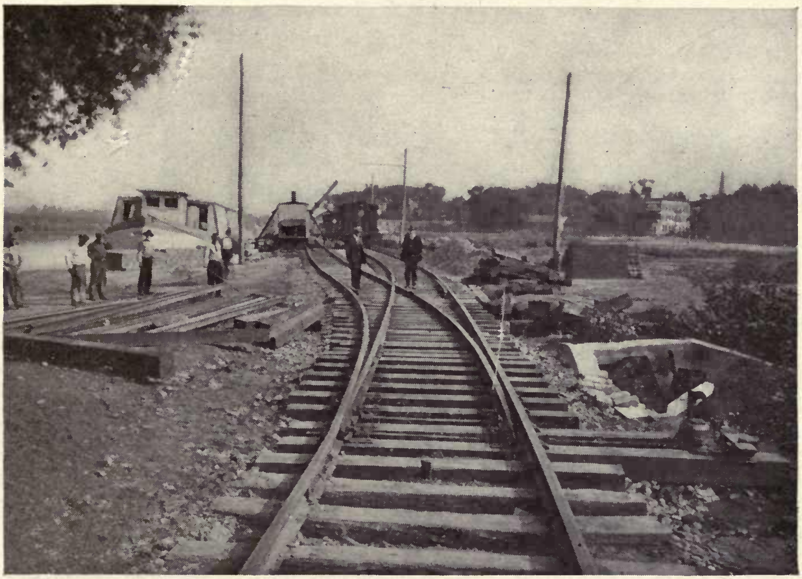
Principle No. 5.—"The equipment should gradually be improved."

In this connection, we find where steel wheels have replaced cast iron wheels, how the flat cars on the narrow gauge are longer and wider than before, and how narrow gauge cars now in use have a carrying capacity of 80,000 lbs.—40 tons—the equivalent of the average modern large sized freight car in use on the railroads.

AN IMPOSSIBLE PICTURE.

Can you imagine the main avenue of the General Electric works as it would be without its railway system? At dinner recently one of the transportation engineers was asked how many horses would be required to move the freight which is handled every day—thousands and thousands of tons—in the General Electric works. He roughly estimated that 5,000 horses could not do the work. But let us suppose that 5,000 horses could do the work—2,500 teams—it would be like working in one great stable. It would require one of the largest buildings merely to afford these horses a sleeping place at night. A small army of

men would be required to keep the horses clean and fed and watered. There would be at least one run-away every day, not only destroying property and risking life but seriously interfering with production. An engineer and a motorman are skilled in the handling of machinery—while a teamster is generally supposed to be more skilled in the handling of profanity than anything else, especially when his wheels lock with the wheels of an-



Where the Schenectady Works Railway system connects with the New York State Barge Canal. The loaded cars on this siding are unloaded by the mechanical stevedore. Incoming freight is also received here from the Great Lakes and New York ports.

other truck. Hundreds of wagonloads of corn and oats, hay and straw must be brought in every day, and other hundreds of wagonloads of refuse must be carted out every day. Think how much time would be wasted in the morning hitching up the horses —how many horses would be sick—undoubtedly it would need a corps of veterinary surgeons to keep the horses in working trim—there is no end to the speculation as to "what might have been."

Albert Hammond, yardmaster in charge of the narrow gauge system in theworks, said that the average train carries 144 tons of

freight—not counting the weight of the train itself. He doubts very much if 144 horses hitched together, 72 teams, all in tandem, could start a train of this size, because they would not pull together. Even if there were 50 drivers, cracking whips and urging the horses forward with their usual persuasive language, it probably could not be done—even for one train not to mention the scores that are continually under way.

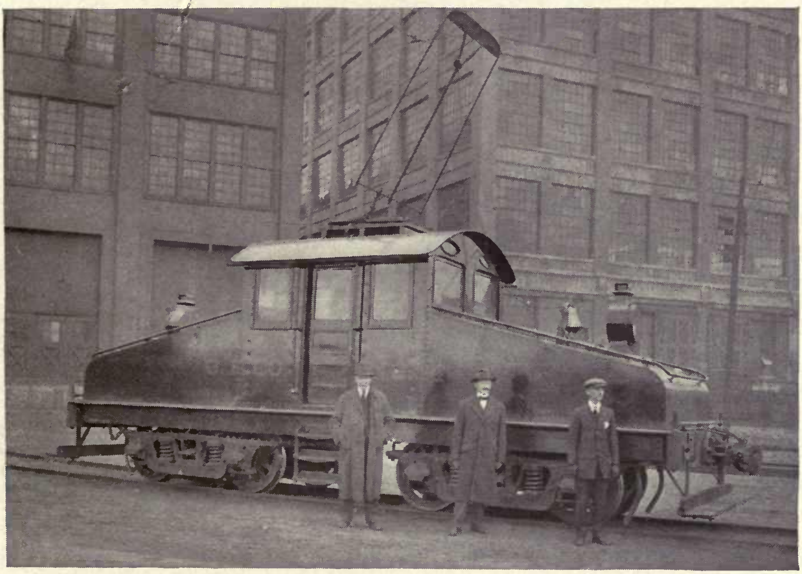
Part of the one-hundred miles of railway tracks inside the Schenectady Works. The athletic field grand-stand is shown on the left, and the New York State Barge Canal Terminal is on the right.

BUILDING TRANSPORTATION CREW.

One might suspect from the smoothness with which this system operates, that it was directed by a master hand. The Schenectady works is as unconscious of the service rendered by its transportation system as you are unconscious of the service rendered by the blood which circulates in your veins, and which is so necessary not only to your health and energy but to your very life itself.

TRANSPORTATION BRAKEMAN TO MASTER.

Twenty-four years ago, a boy applied for a position with the Pennsylvania railroad in Chicago. He was given one of the toughest jobs—brakeman on a freight train. After about five years of this kind of work in all kinds of weather—the biting wind off of Lake Michigan in February — climbing the ice-incrusted cars in those strenuous days before the air-brake was generally adopted—finally his work was changed to that of freight conductor.

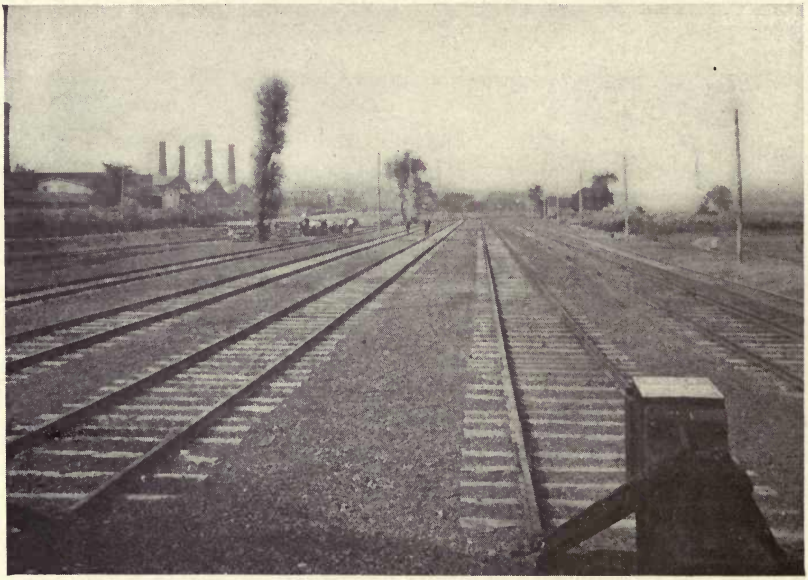


Close view of standard gauge electric locomotive. From left to right: Thomas Kearney, James H. Rosenstock and Henry K. Baumis.

Faithful, dogged perseverance, intelligent service, unflagging industry coupled with a deep grasp of terminal problems won for him the position of yardmaster in 1902, after eight years spent in mastering the details of handling freight.

So smoothly were the yards of the Chicago division of the Pennsylvania Railroad handled, that this young man was sent to Pittsburgh where he was a specialist in the handling of freight congestion. Having perfected the methods there—which methods

are even in use today—1903 and 1904 saw him at the Baltimore terminal, in charge not only of the yard situation but of the lighterage boats in New York harbor at St. George. Then the Baltimore and Ohio Railroad made him general yardmaster of the station at Newcastle, Pa., and by 1906 he had earned for himself the position of supervisor of terminals. The Delaware and Hudson Railroad next obtained his services and for eight



Some neat railroad construction work. Transcontinental Railway Systems have few track-building tricks which are not known by the Schenectady Transportation men.

years he was their superintendent, stationed at Oneonta, N. Y., and Carbondale, Pa. The years 1915 and 1916 saw him superintendent of terminals of the Western Maryland Railroad at Hagerstown, Md., and now he is master of transportation of the General Electric Company at the Schenectady works.

But James H. Rosenstock, in looking back over his years of hard apprenticeship, says the one greatest thing for successful railroad operation is "co-operation." And all along the line you will find this co-operation exists—permeates the very atmosphere of the transportation department. And as a matter of

fact, it is easy to get and give co-operation when one is surrounded by a crew of men who understand their business.

J. F. Henry is general assistant to the master of transportation. A short chat with him shows that for the last 15 years he

Organization of the Transportation Department. Reading from left to right: Thomas L. Kearney, Road Master and Supervisor of Tracks; Peter VanVorst, Master Mechanic, Division of Locomotive and Car Repairs; Henry K. Baumis, Yardmaster in charge of the standard gauge; Frank Edelman, Assistant Yardmaster, standard gauge; Arthur Roach, Car Record Clerk; Louis Hirschmann, Chief Clerk; Catherine Barrie, Train Dispatcher and Car Distributor, Narrow Gauge; James Reardon, Assistant Division Man; Helen Nolan, Time keeper; W. Disbrow, Assistant Division Man; J. F. Henry, Assistant Master of Transportation; C. W. Hines, Assistant Yardmaster; J. J. Rosenstock, Master of Transportation; F. J. Smith, Assistant Yardmaster, Narrow Gauge; A. Hammond, Yardmaster in charge of the Narrow Gauge; H. A. Stevens, Night Yardmaster; J. C. Drum, Assistant Yardmaster, Narrow Gauge.

has been tally man, car tracer, division foreman, time-keeper, assistant accountant, car demurrage clerk, chief clerk and accountant and now he is assistant to Mr. Rosenstock.

THOMAS KEARNEY.

Thomas L. Kearney, roadmaster and supervisor of tracks has to his credit 25 years of railroading experience with the New York Central Railroad before he came with the General Electric Company and he has been in the Schenectady transportation

These railroad tracks carry General Electric freight, from the factory shown in the background to the terminal of the State Barge Canal. This gives a water connection with New York City and the Great Lake ports.

department for 16 years. Mr. Kearney has had charge of laying all of the tracks within the works since 1902—and the laying of every track west of building No. 18 was supervised by him. In 1906 he had charge of a gang of 70 laborers who moved the dike from near building No. 77 to beyond the coal pile where it

is at present. This calls to mind the fact that most of the ground occupied by the General Electric works at present was reclaimed from the river bottom and "filled in." For two years the railroad delivered 140 cars of sand every day and Mr. Kearney had charge of locating them and dumping them at the proper places. In his early apprenticeship with the N. Y. C. he was a section laborer for four years, a section foreman for 10 years, laid the tracks at the Buffalo terminal out as far as Depew, and installed miles of track at Rensselaer and Poughkeepsie. He laid the experimental track within the G. E. works in 1902 and this year has just completed the new terminal at the Barge Canal which permits G. E. freight shipments to be sent by water to New York harbor. The biggest job he ever had was in 1904 and 1906 —changing the entrance of the N. Y. Central tracks—shifting them from the entrance at the north side of the works to the present siding on the south side.

A FACTORY WITHIN A FACTORY.

Peter Van Vorst, master mechanic of the division of locomotive and car repairs, conducted me over the car shop in the transportation building No. 84. Van Vorst keeps all the cars and locomotives in A-1 shape. It was he who put the cabs on the electrical locomotives and thus protected from exposure the engineers and motormen who serve the works regardless of rain and the bitter cold winter.

The new type of bow trolleys which automatically reverse, were built in his shop. Not only do they repair the locomotives and cars, both narrow gauge and standard gauge, but they actually build new cars in the shops which Van Vorst opened when he came with the General Electric Company in 1913. He likes electric locomotives, says they are healthy and clean and safe. He takes pride in looking over all of the 21 locomotives, oiling them, tuning them up and having them ready every morning for immediate service. His days of steam railroading made him appreciate the convenience of the electric type; for in the old days the firemen and engineers had to spend an hour to an hour and a half in the morning getting the steam locomotives ready for work.

Van Vorst also knows the details of railroading life, because

for 13 years, working 12 hours a night, he was freight brakeman, switch tender and yard brakeman on the N. Y. C.; later being promoted to yard conductor, then yardmaster and finally general yardmaster between 1900 and 1913. It was during the time he was general yardmaster that the New York Central tracks were elevated in Schenectady, and that one job, he says, was an education in itself. Van Vorst says that no experience is wasted and points to the fact that he served four years apprentice course as a machinist at the Schenectady Locomotive works, now the American Locomotive works. Even today he can step up to a lathe and turn out a rush job in an emergency. One of his most recent jobs was to change all the wheels on the narrow gauge cars from cast iron to steel—thus improving the service.

ALBERT HAMMOND.

Albert Hammond, yardmaster of the narrow gauge system who has been with the General Electric Company 12 years, began his 22 years of railroading experience with the New York Central railroad. This man, who is in charge of shipping millions of dollars worth of delicate electrical machinery back and forth in the factory, started his career as a "baggage smasher" on the N. Y. C. He worked his way up to switch tender, yard brakeman and yard conductor, when in 1906 he started with the General Electric Company as a night brakeman.

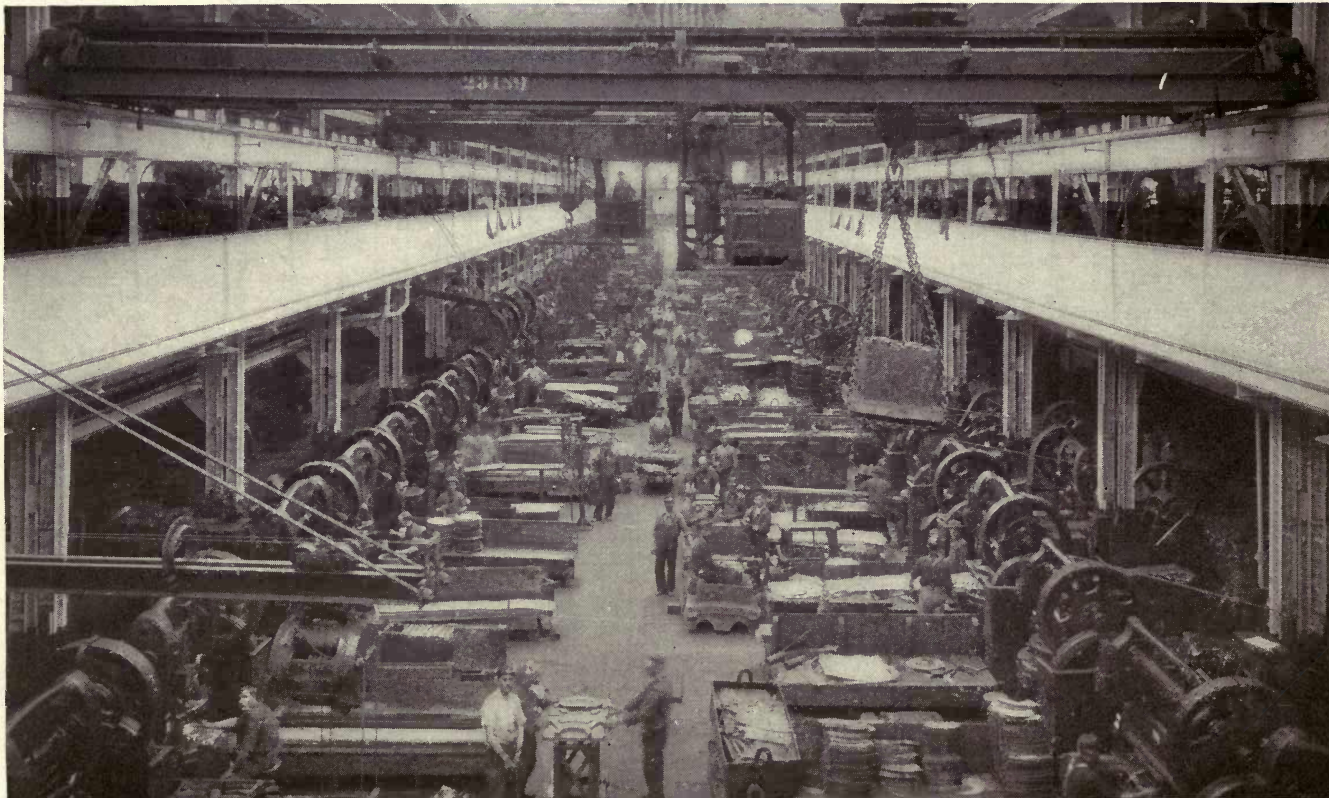
The great big asset of practical experience in railroading could be illustrated again and again—C. W. Hines, assistant narrow gauge yardmaster, was formerly a motorman for the Schenectady R. R. Company, and Frank J. Smith, assistant yardmaster, was at one time a gripman on the Metropolitan Street Railroad in New York, at the time of the old cable cars; Frank Edelman, assistant yardmaster of the standard gauge system, spent six years with the Delaware and Hudson Railroad, four years as a telegraph operator and two years as a brakeman; and Henry K. Baumis spent 15 years with the West Shore and the N. Y. C. as a practical railroader; Joseph Drum is a graduate car dispatcher. Harry Stevens is the night yardmaster of the standard and the narrow gauge. He was freight brakeman and conductor on the Baltimore and Ohio for three years, motorman on the S. R. R. for one year, entered the G. E. Company in 1906 as a brakeman

and has successively been promoted to conductor, assistant yardmaster, and now he is night yardmaster.

Catherine Barry replaced a man and is now a full fledged train dispatcher and car distributor on the narrow gauge system.

ORGANIZATION OF THE TRANSPORTATION DEPARTMENT.

James H. Rosenstock, Joseph S. Henry, Thomas L. Kearney, Peter Van Vorst, Albert Hammond, Henry K. Baumis, C. W. Hines, Frank J. Smith, Joseph Drum, Frank Edelman, Harry Stevens and Catherine Barry.



General view of Building No. 17. The crane man is everybody's friend because he gives everybody a lift.

CHAPTER VII

CHEWING STEEL LIKE PAPER

NO PLACE IN WORKS MAKES AS MANY MILLIONS OF PRODUCTS AS BUILDING SEVENTEEN—TWENTY SEVEN THOUSAND TONS OF SHEET METAL USED IN A YEAR—CONSERVATION PRACTICED—TESTERS ON THE SPOT.

I had the good fortune to go through building No. 17 with the foreman, A. K. Christie.

There is no place in the General Electric Company that makes as many millions of finished products as building No. 17. I walked, amazed, between long rows of ponderous punch presses, some of them pounding as fast as a machine gun—400 punches per minute. Some of these great presses appear three times as tall as a man. All of them punch cold steel 100 times faster and more accurately than an old-fashioned workman could with any tool. Some are auto-fed, some auto-stop, some both; and all of them are producers.

Building No. 17 stands between the Pittsburgh steel mill and the finished Schenectady motor. Without sheet steel, rapidly and accurately stamped out into laminations, the cost of an electric motor would be 10 times what it is today. So the marvelous processes that are carried on in this busy building, make electricity more available to the factories which are the backbone of industry today, because they lower the cost of the motors. It is simple reasoning:

With the universal aid of electricity our country can produce more work. With low priced, accurately made motors America will use more electricity; so, building No. 17 helps "Make America Efficient."

IMPORTANCE SHOWN

The importance of the work done in building No. 17 is shown by the following table giving the weight of materials in a small Schenectady motor:

Punched steel laminations from building No. 17	40%
Cast iron frame and sides	35%
Copper windings	15%
Steel shaft, etc.	10%
Total	100%

Twenty-seven thousand tons of sheet steel entered building No. 17 last year and most of this was only one sixty-fourth of an inch thick. If this amount of steel were to be laid out in a band one foot wide, it would encircle the earth. Sheet by sheet this vast steel pathway is fed into the crunching jaws of the punch presses. There are 140 of these monsters in building No. 17 alone. If these machines would all run continuously for one hour they would make almost 1,000,000 stampings. If run continuously for one year, night and day, they would make over 5,000,000,000 stampings.

DEALS IN MILLIONS

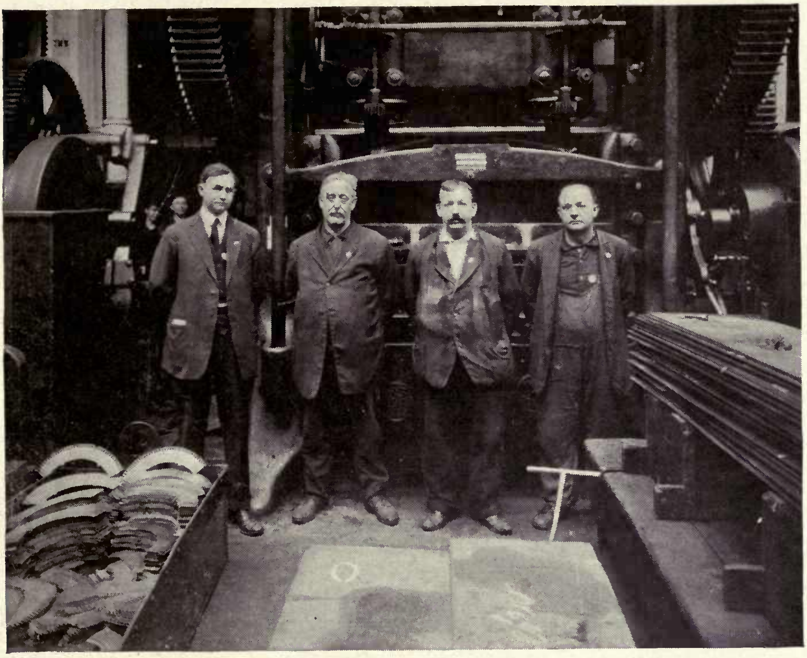
So it will be seen that the men in building No. 17 deal literally in millions, and that the aggregate total of a year's work can easily reach a billion of pieces finished ready for assembly in electrical machinery. Day and night the steel is punched from the thickness of one one-hundredth of an inch up to one-fourth of an inch. It is not only punched out of the strips of metal which are fed into the machines, but it is perforated with holes in the middle, holes round and holes oval, slots square and rectangular, notched and plain, and all punched so smoothly that the ordinary citizen would be ready to swear that they had been carefully drilled in oil and filed smooth by a skilled mechanic.

SECRET OF IT ALL

The secret of making these holes so smooth and so rapidly is that the dies are well made, of exceptionally hard steel, and are kept sharp. In five minutes one of these dies can be removed from the machine, put on the grinding wheel and ground so sharp that it is likely to cut a visitor's fingers, and then returned ready to resume its ponderous activities.

Aside from lifting single thin sheets of metal into place, there is little lifting done by the operators of these machines. Three overhead electric traveling cranes deliver the material, and elec-

tric hoists are supplied for lifting it practically to a level with the machine. There are eight electric hoists and four hand or chain hoists in the building.



QUARTET WORKS 115 YEARS IN G. E. PUNCH PRESS DEPARTMENT.

These four men have worked 115 years for the General Electric Company. They are members of the Quarter Century Club in Building No. 17. The little blue button worn in their left hand coat lapel adds more dignity and prestige than almost any other insignia. Reading from left to right the men are: A. K. Christie, foreman, 27 years; Edward Stevens, die setter, 32 years; Matthew Farnum, press operator, 29 years; John Lasher, die setter, 27 years. In the background is one of the giant punch presses towering high above their heads, and to the left is a box of punchings which will later go to make up 40 per cent of an electric motor.

AUTOMATIC FEED

After the strips of sheet steel are ready to start into the machines, the automatic-feeding devices which employ steel fingers almost human, feed just the right amount of steel, little by little, into place under the powerful jaws of the punch press.

This not only conserves the strength of the men, but it is a safety factor rendering it unnecessary for a man to get his fingers in a position where they might be caught in the machinery.

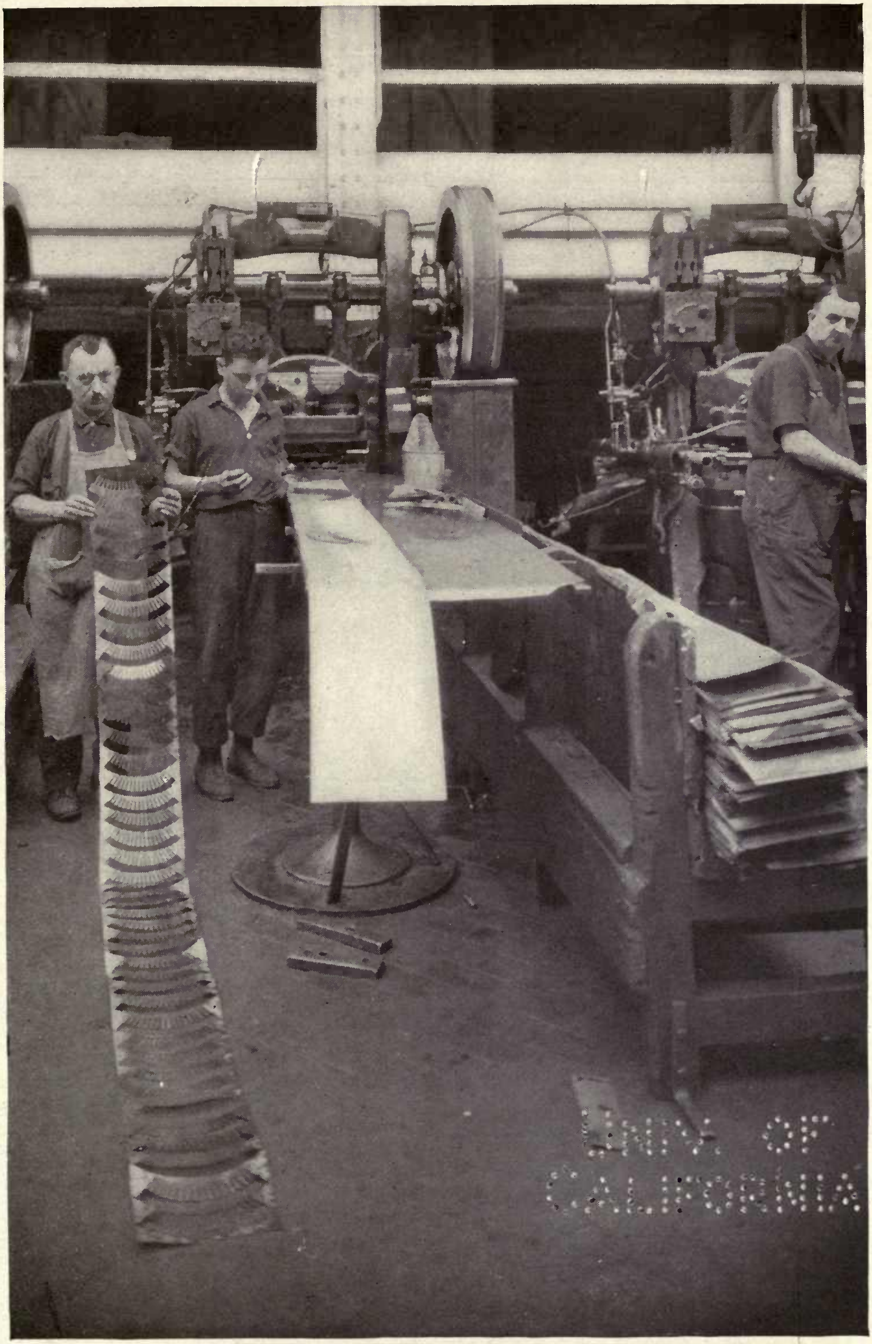
There are several remarkable machines in building No. 17, which punch steel as fast as a woodpecker pecks wood. These make 400 single punches every minute—about 7 every second. Another makes nine punchings—that is, nine finished pieces at every stroke of the machine. Mr. Christie says this machine made a world's record run for, with one sharpening of the dies, it turned out 2,250,000 finished pieces of cut steel ready for assembly—right out of the cold raw steel from Pittsburg.

CONSERVATION OF METAL

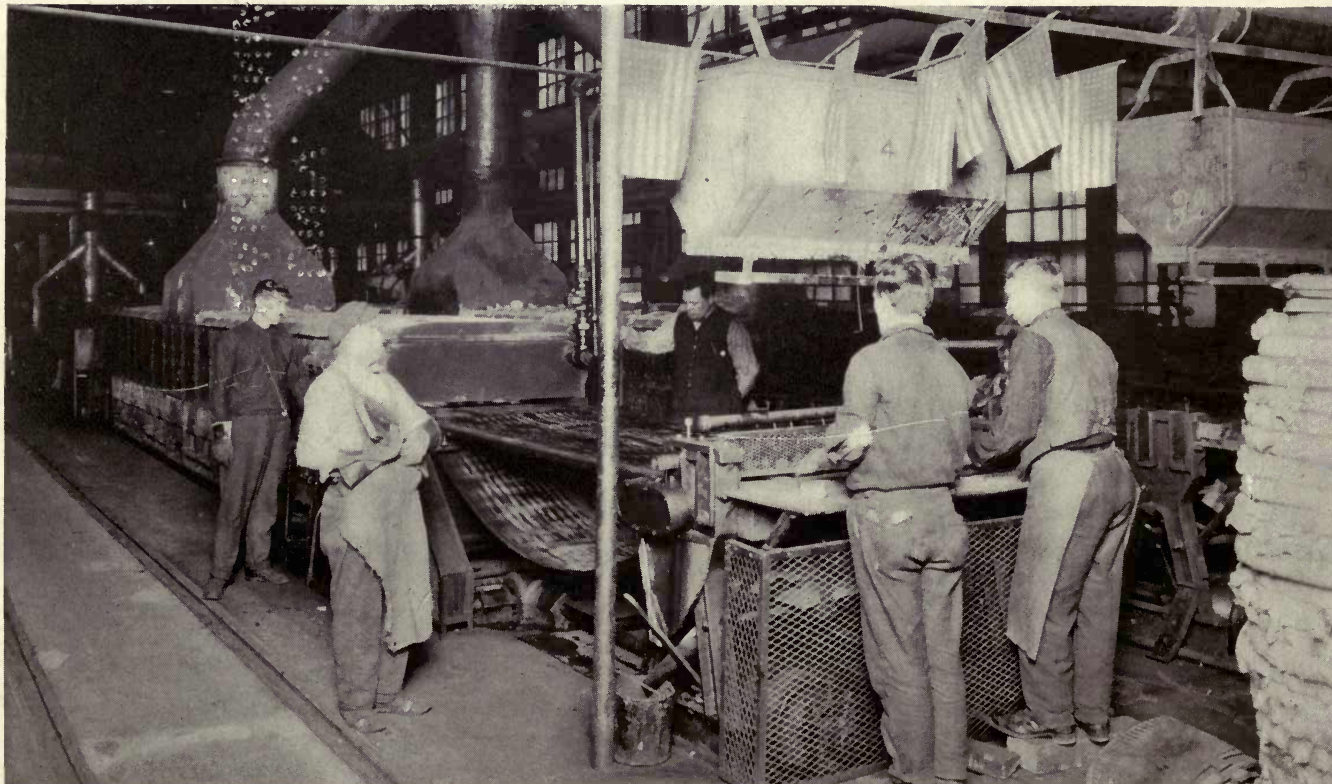
Nothing is wasted in building No. 17. The thoroughness with which the metal is used is characteristic of the reclaiming of the by-products in any complex industry. In the south cotton is run through the cotton gin and cotton seed oil is made out of the seeds. In this great building they run the metal through the machines, get one or two finished products and then the trimmings are sent back to Pittsburg to be reformed into new sheet metal.

Last year several thousand tons of this steel was turned back for use by American industry instead of being dumped on the river bank as was done by some factories years ago. In some cases two different finished products are gotten out of each sheet of metal before selling the scrap for cash.

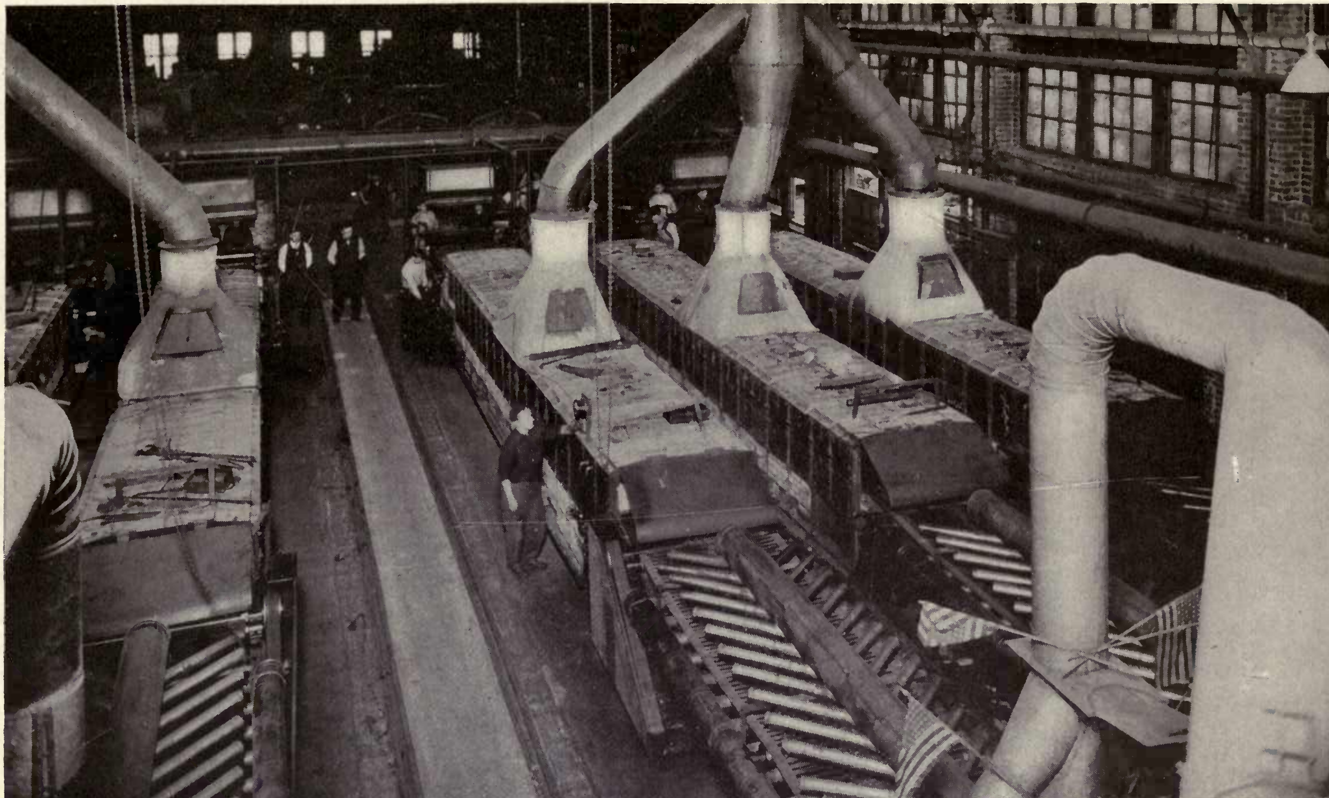
One of the very latest developments in the manufacture of electric motors is the new method of "pouring the wires." Literally the wires in the rotors of some of the motors now being turned out are poured in, and not wound in, as is generally supposed to be the case. And it is building No. 17 that makes this possible by the clever way in which the sheet steel is punched—merely punching a hole instead of a slot, and then when the laminations are put side by side the holes become a mold. The melted metal is poured in, after the motor is assembled, and in the twinkling of an eye the motor is "wound." The punch press department has turned out hundreds of thousands of parts for this new type of motor.



These wonderful machines in Building No. 17 chew up Pittsburg steel as if it were paper. The long strips of sheet steel are fed to the machine automatically so as to save the strength of the operator. Henry Hammer is proud of the accurate work which he is exhibiting. His assistant, Michael Buzzo, is inspecting one of the laminations stamped out by the machine. John Ravencroft is shown setting the dies on the next punch press on the right.



An interesting picture in Building No. 19 showing how the laminations are automatically coated with enamel and travel on the moving steel belts into the big furnace. The steel box above the two men to the right, contains sawdust for the rapid extinguishing of a possible fire.



Picture in Building No. 19 showing the movable metal belt which travels through the oil burning furnaces. Laminated punchings are automatically given a coat of enamel, this is baked in the furnace, the laminations come out on the metal belt and are dried by compressed air in the herring-bone pipes shown in the foreground. Note the elaborate piping to the outer atmosphere which removes the products of combustion and keeps the air pure.

INSTANTANEOUS ELECTRIC WELDING

Building No. 17 contains other interesting things besides punch presses and their myriad productiveness. In addition to billions of punchings, there are millions of electric welds made annually—each one made in half the time it would take you to lick a postage stamp!

If you have never seen electric welds made in a fraction of a second between two pieces of steel, and made so securely that two teams of horses could not drag them apart, this achievement will be difficult for you to appreciate; but the men in shop No. 17 can tell you the technical details of these latest products of the electric art. There is nothing that is more engrossing the attention of the shipbuilding world today than electric welding, and right here in Schenectady can be seen these 20th century marvels helping to manufacture electric motors.

There are 20 of these machines, each one making an average of 6,000 separate welds every day. If they were working continuously night and day throughout the year they would make over 100,000,000 welds, each one complete and smoothly finished and needing no filing or attention whatsoever.

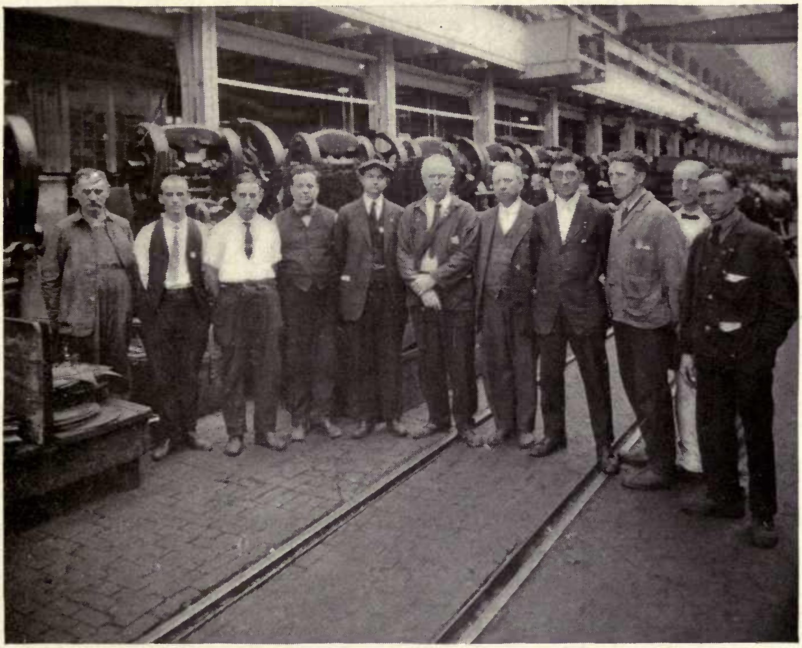
TESTING STEEL

The mechanical engineer designed the punch presses in building No. 17; the electrical engineer designed the electric welding machines; but behind them all, more or less invisible, is the intelligence of the chemist, who must approve every shipment of steel before it is unloaded from the cars. A special kind of sheet steel is used and the testing laboratory has established a branch in building No. 17 so as to be close to the manufacturing processes and o. k. every piece of steel before it goes into an electric motor.

Chemists found that after the sheet steel is punched it becomes hard; and so they heat the iron in three big annealing furnaces to correct this, as well as to improve the magnetic quality. Here the electrical engineer and the chemist again link their talents. Electric pyrometers measure the temperature every half hour, in 10 different places, in each of the three great furnaces. And night and day, 365 days in the year, 60 temperature readings are made every half hour and recorded. Literally tens of

thousands of these accurate painstaking readings are made every year so as to maintain the temperature even during the annealing process.

These furnaces use oil burners somewhat similar to those under the boilers of our battleships.



Organization of the Punch Press Department. From left to right: Thos. Lonergan, Fred. Archibald, Jos. Briggs, Wm. McNaughton, A. K. Chuster, Thos. Guer, H. R. Decker, Ed. Slocum, T. Beck, Hy. Burmaster, E. Bernier, S. Pipa, M. Hesick, R. Tariello, M. Ruggiero, W. Reynolds, John Spencer, J. Kristenek, J. Szlachtowski, Ed. Stevens, Mathew Farnum, John Lasher, J. Cemka, M. Malziere.

THE AUTOMATIC FURNACES

But even after being punched and annealed, and cooled some of the laminations are not yet ready to put into assembly of a motor. Six great roaring, japanning furnaces or enamelling ovens, which also burn oil, have a travelling iron floor; and automatically after the single laminations are placed one by

one on this traveling floor, they are coated with enamel on both sides, the enamel is then baked in the furnace, they are carried out and cooled by jets of air; and then they are shining, polished and clean, ready to send to the assembly division and then take their place as "40 per cent of a finished motor." One is reminded of the Ford auto factory in Detroit, where the conveyor belts are used so extensively. This iron floor changes in temperature every few minutes, from the temperature of the room up to many hundreds degrees Fahrenheit as it passes in and out of the furnaces.

But despite all this heat and despite all this enamel and oil, the air in the room is quite pure, and not the least bit uncomfortable.

The liquid enamel is pumped and strained and even tempered by machinery so as to obtain uniform results.

Metal binding strips which are used in the shipping department for strengthening the boxes that hold the finished machinery, are likewise run through this machine and enameled so as to prevent their rusting.

ELECTRIC FURNACE

Upstairs in building No. 19 are electric furnaces used for tempering dies and tools used by the punch press men, and the temperature in these is as delicately regulated as in a chicken incubator.

CHAPTER VIII

"GILES' AVIATORS"

WHAT GIGANTIC OVERHEAD ELECTRIC CRANES DO; HOW IT FEELS TO RIDE IN ONE AND HOW THE GREAT SHOP LOOKS TO THE CRANE OPERATOR AND HIS GUEST, DESCRIBED THROUGH AID OF MISS EDISON ON THE SPOT.

THE CRANEMAN

I'm the "man way up" at the very top,
    Where a wise guy ought to be;
I'm the boy that's over the bloomin' shop
    An' you gotta look up to me,
For I rides in my carriage to an' fro
    Like a millionaire's private train,
An' we sure looks down on the gang below—
    Me and my travelin' crane!

It's up and back on the same old track,
    Whenever we gets the hail,
Fer she answers grand to a touch o' me hand
    And her strength don't never fail;
You'd think she'd run by her own good brain—
    There's quite some class to a trav'lin crane!

There ain't no burdens too large for us,
    Me an' this crane of mine;
We lifts the biggest without no fuss,
    For that is the way we shine;
We takes 'em any old shape or size
    An' juggles them thru the air,
An' lowers 'em carefully easywise—
    When it comes to the job, we're there!

We rumble a song as we roll along,
    A sort of a happy hum,
Oh, we can swing any doggone thing
    That happens our way, by gum;
Give us a chance and we'll prove it plain—
    Me an' my lady, the travelin' crane!

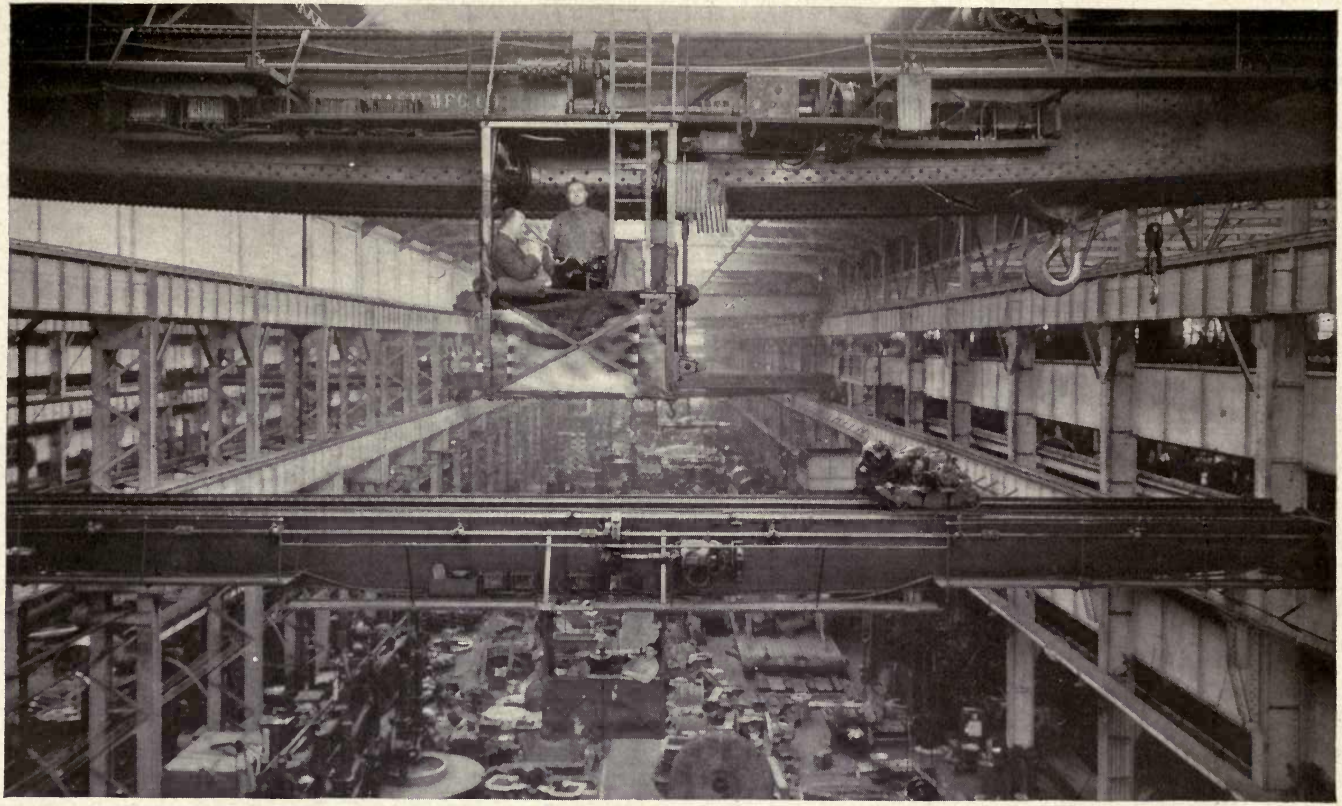
Old Hercules is an also ran,
    An' Samson's piker, too;
They was pretty good on a small-size plan,
    But today they'd never do;
We've got 'em faded, we've got 'em stung,
    They could never stand the strain
Of the stunts we do an' the loads we've swung—
    Me an' my travlin' crane!

Its sweet she rungs, an' it's neat she runs,
    An' gentle she is to guide,
An' to sit here tight and to drive her right
    Is a job that gives me pride,
From wheels an' girders to hook and chain—
    There's quite some class to a trav'lin crane!

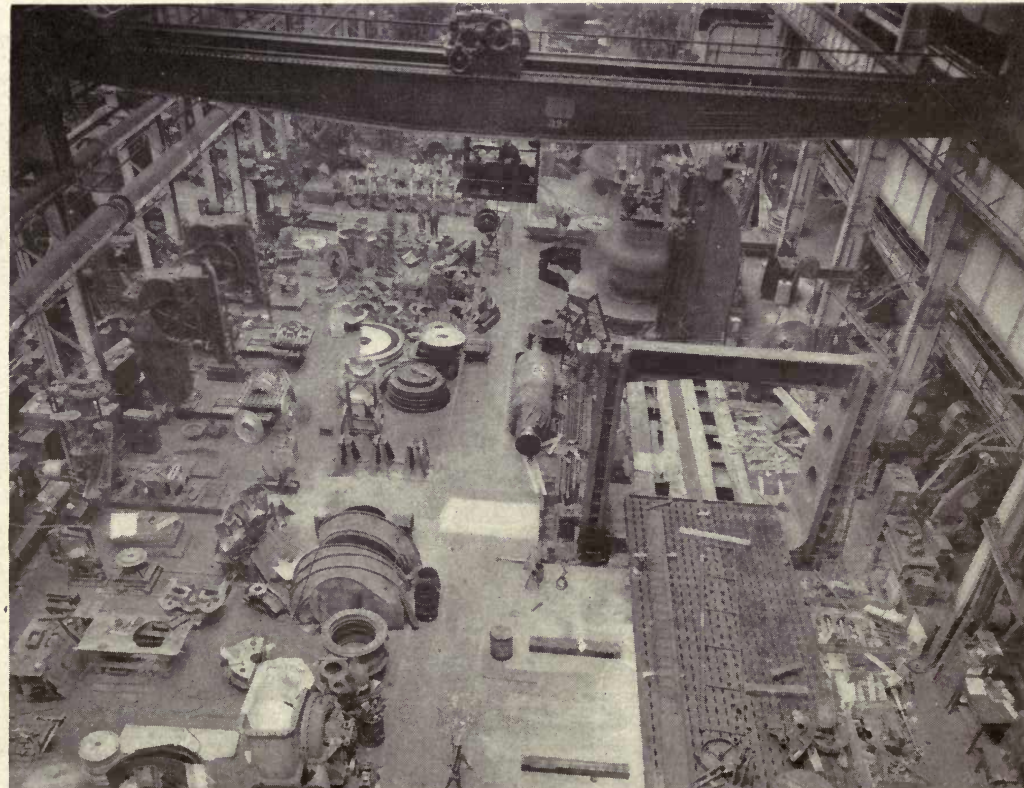
—BERTON BRALEY,
In the American Machinist.

I was escorting a party through the General Electric works last month and, by the merest chance, that visit brought about one of the most thrilling experiences of my life. In this party was a boy nine years old. As we were walking along the highest gallery in building No. 60, we exchanged a friendly nod with Ben Frederico, the crane operator of one of the highest cranes. Ben must have children of his own, because he invited nine-year-old Herbert to have a ride with him way out high up over that throbbing shop.

After fifteen minutes the boy came back—his eyes like saucers —fairly dancing with joy as he described his great adventure. I envied not only his experience, but his enthusiasm, and I resolved to duplicate his trip myself. Since most pleasures in life are more keenly enjoyed when we share them, I decided to take along



View of the Grand Canyon of Schenectady showing how the cranes run above one another. Ben Fredrico is standing in the cage and the author is dictating to "Miss Edison," the story of how it feels to ride in an overhead crane.



Another crane picture showing on the right the largest planer in the works under process of construction. In the background are two boring mills in operation, at the top is one of the crane men on the lower level. A few men are visible in this picture.

my private secretary on this trip in the overhead electric crane, thinking that the two of us might be able to write a story of how it feels to ride with the men who handle tons of freight by their novel aerial transportation system. Perhaps I should explain that my private secretary is an "Ediphone" or Edison business phonograph, and she can write as fast as I can think and as fast as I can speak.

"MISS EDISON" READY, TOO.

I am almost ready to climb aboard the crane. "Miss Edison" is already seated waiting for me, and after I occupy my place at her side I am going to tell you how it feels to ride close under the rafters of building No. 60, on one of the 35 ponderous cranes that handle the freight within this great building.

But before I climbed aboard Otis Lawyer took a ride on the crane and took four photographs looking straight down on the busy shop.

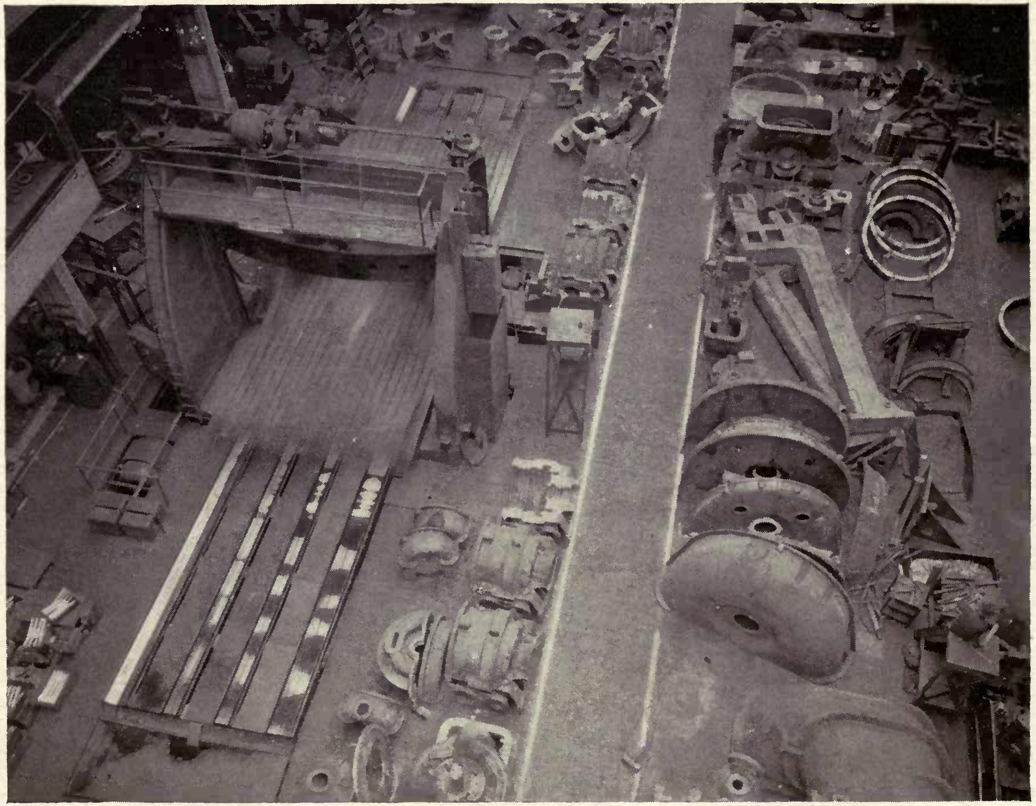
Frederico gave me a helping hand and I climb from the balcony aboard his car, nearly 70 feet above the floor. He has a neat cage with four controllers, each similar to those on a trolley car. I pick up the mouthpiece of the phonograph and start to dictate.

I am going to tell you just what happens, when it happens and as it happens; for I can keep my eye on the work that is being done by the crane without stopping to make any notes with pencil or paper.

We are ready to start. Smilingly Ben says: "All aboard"—throws one of the controller handles a notch to the left and—we are off; It is just as it must be to ride in an aeroplane for the first time—slow at first and then faster and faster, we apparently leave the ground and sail out over the 3,000 men working beneath us. I look down on a flood of boring mills, drill presses and lathes—all streaming past my gaze. And on we go toward the middle of the big building, propelled by the electrical motor of the crane.

PASS ANOTHER CRANE

Now we pass over another crane—for it should be understood that in this building—some claim the only one in the world—crane is over crane, they are double-decked like the New York Grand Central depot, which has one set of tracks above the other.



View of the floor from one of the top cranes in Building No. 60, showing a big planer in motion. Note how carefully the white lines are respected so as to keep the aisle clear.

I have no feeling of being afraid, because Mr. Giles, the superintendent of cranes, told me I would be safe with Ben Frederico. He has been an expert operator for 20 years, every month of which was spent in the General Electric shops. I look ahead and on the next crane, operated by Lorenzo V. DeSerbo, I read the impressive inscription, "100 ton Niles crane." Behind me I see another crane, which says: "50 ton Case crane; Columbus, Ohio." A crane moves beneath us with 30 tons of cast iron on its way down the shop from one machine to another. It is directly beneath us and I can see what only crane men have seen before—the working of the carriage which runs back and forth on the crane as viewed from above. Of the 23,000 employes in the General Electric works, probably not 1000 men have ever before had the view of a crane which I have at this instant.

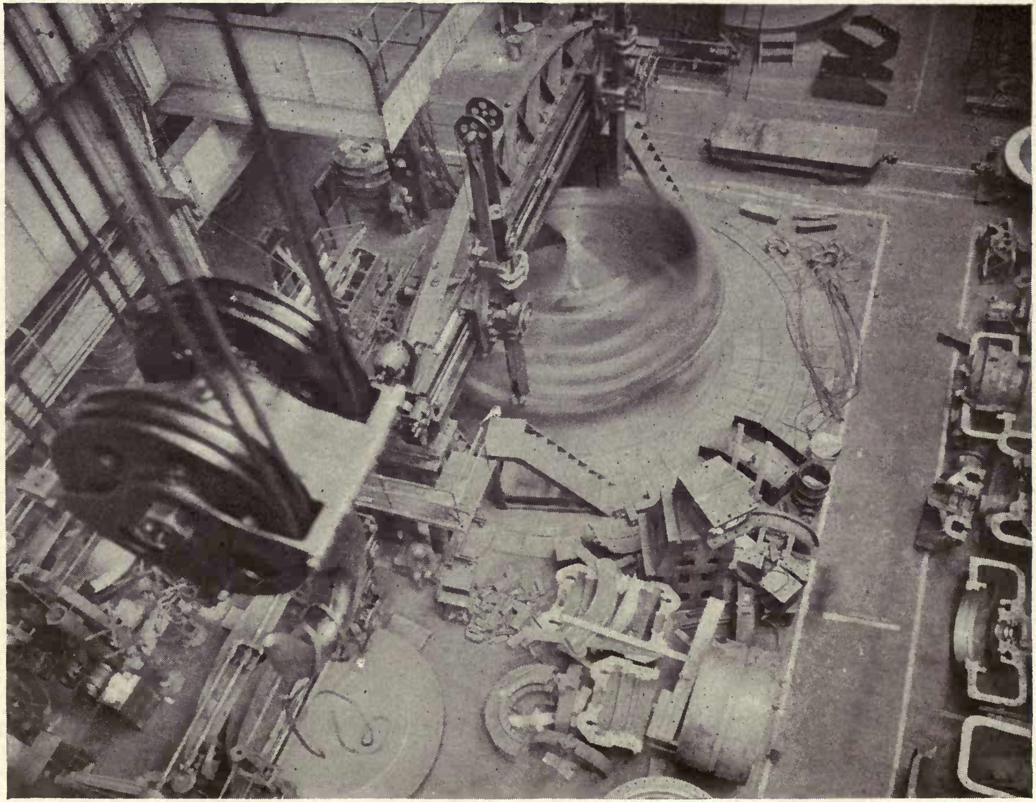
We start again—down the shop. Rumbling, vibrating—on we go. I see the rough castings now becoming finished portions of the weird steam turbines which furnish electricity for the country. One second ago, we were above one of the largest planers in the world; now we are above the iron floor where the great turbines are assembled; now where the rough steel forgings are delivered which will later make the revolving field of a 50,000 kilowatt turbine-generator.

GATHERS MOMENTUM.

Faster and faster we go, and now at top speed we are going the length of the building, nearly 1,000 feet long and 300 feet wide. I would estimate roughly that we are moving as fast as an ordinary freight train—one of the main differences being that the rails on which we are running are 75 feet apart, and Ben and I are poised midway between them. As we approach the end of the building, a slight turn of the controller handle slows us down, and then by applying the foot brake, we stop accurately within a half inch of the end of the runway.

One man climbs out of the crane next to us, and another man climbs on, taking his place. I ask Ben what that meant, and he said the man who just got off, was the relief man. Every crane operator is relieved every morning and every afternoon.

A craneman is a birdman, the same as an airplane man. He does the work of an elevator operator and of an engineer. He not only goes straight backwards and forwards along the length



Interesting picture of boring mill in operation taking a cut on a 35,000 kilowatt turbine casing. Note also the big pulley and hook on the left.

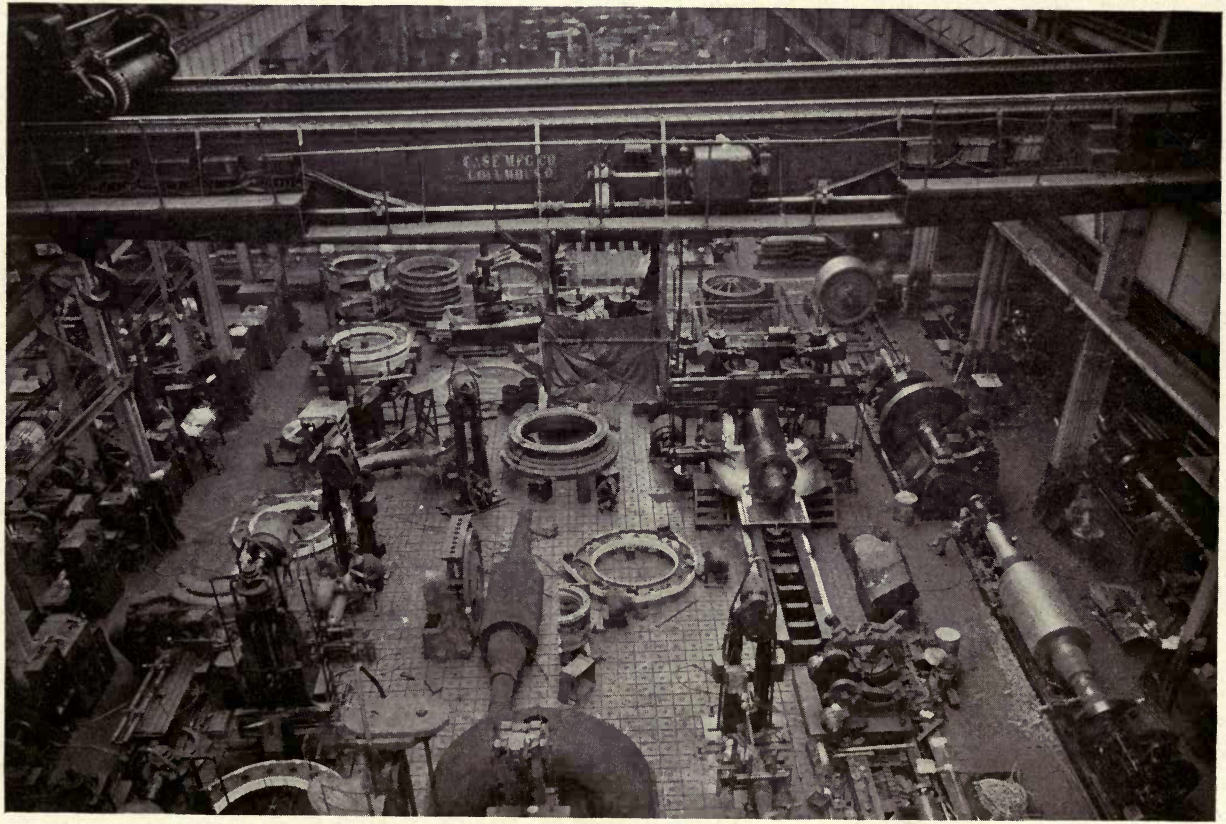
of the building, but he also runs his carriage back and forth from one side of the building to the other; raises and lowers the two giant steel hooks from the topmost position down to a level with the floor. And often he does all three of these things at the same instant. Now he is doing three things at the same time, running south along the building, directing the carriage from the western side to the eastern side of the building, and also lowering the hook to the ground. I am now following the hook as it goes down 66 feet to give a man a lift. And we should remember that the crane man is everybody's friend because he gives everybody a lift.

DIRECT FROM FLOOR.

The crane follower (on the floor) directs where he wishes the huge hook to be lowered and then he takes a steel rope and ties it around a giant casting lying on the platform of one of the boring mills. This casting will soon be part of a steam turbine. The steel rope is tied to the great piece of iron, the signal is given, Ben throws one of his four controller handles, and—presto—the iron begins to ascend toward us.

At a signal from the man on the floor we run backwards a few feet so that the iron will clear the boring mill and then the load is deposited on the floor. A new hitch with the steel rope and the great piece of iron is pulled up on one end and laid over on the other side. A third hitch is made with the steel rope and we again lift the huge mass of iron and start back toward the boring mill from which we removed it. Accurate within an inch we stop opposite the machine. Another lever is thrown on a different controller and the 25 tons of cast iron is deftly deposited in the exact mathematical center of the boring mill—total elapsed time by the watch 35 seconds! And before I finish describing the process, the big hook has come up to a level with our eyes again and we are ready for another job.

As we hesitate here a moment under the roof, the man on the crane beneath us makes a signal, and Ben lets down a small paper clip on a string—for such is the private internal mailing department of the crane boys. The man who made the signal now takes a piece of paper and puts it in the paper clip. I ask Ben what is up and he says, "Frederick Turnbull, in the next crane below



One of the great iron floors in Building No. 60, as viewed from one of the top-most cranes. Note the hooks on top of the slotting and milling machines which are carried about by these cranes.

us, is sending us a note." The string is hauled up, the paper taken out of the "mail box," and this is the note that we received: " 'Over the Top With Giles' Aviators,' should make a good title to the story." I don't know how Fred knew that we were writing a story except that he saw the phonograph in operation and me talking into the mouthpiece; but he made a good guess.

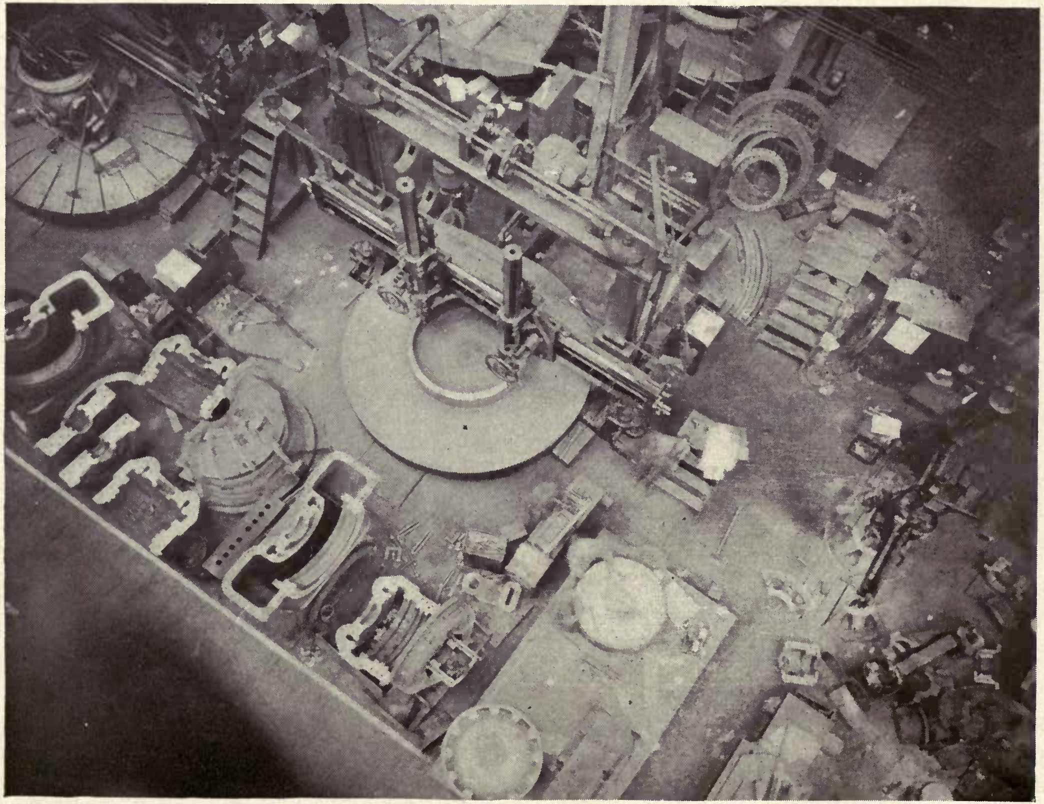
OVER THE TOP WITH GILES' AVIATORS.

So now you can see that the crane men have conversations with each other in spite of the noise of all the machinery and in spite of their distance from each other, both horizontally and vertically. Who would ever dream that they had a more or less secret method of chatting with each other with pencil, paper and string? That was a surprise to me, but it shows that we must get down into the works, before we know what is going on .

We have now run the complete length of building No. 60 and I really do feel like one of "Giles' Aviators." We are now looking down on another iron floor where the wheels are being installed in the steam turbines. Close by is the testing department, and now the hiss of escaping steam is added to the other noises of this greatest of all manufacturing buildings. Below me are steam and electric experts testing a 25,000 kilowatt turbine, amid clouds of steam. The men are swarming over it making adjustments. On the turbine I can count 12 men all at work, entirely unconscious that I am above them and am describing what they are doing. And on my right they have just finished putting a new wheel on a turbine shaft by the shrinking process.

On the opposite side of the room is a 30,000 kilowatt turbine with the top removed. It looks like the entrance to Mammoth Cave, and before long it will be placed on the freight car waiting underneath us to be sent to Cleveland, O., to help illuminate and run the factories of that great city.

Directly beneath me, as we move further down the hall, is a man wearing goggles, making an oxy-acetylene weld on a steam pipe. The brilliant greenish flame shows that the art of the chemist is here dovetailed with the art of the mechanical and electrical engineer. He directs the flame against the steam pipe a few seconds, and it becomes red hot—ready for bending or



Another view from the crane showing two boring mills, the one on the right is in operation and the one on the left is standing still. There were many men in this picture but since it was a time exposure, they eliminated themselves from the picture by their activity.

welding. One of the interesting things about this is that those below me don't know that they are being observed.

I am now looking down on Frederick Turnbull, see his foot on the brake, and his two hands working the four controllers behind his back. I have now learned for the first time that when a crane man is doing a job, his entire attention is focused on the man below, and that he, the craneman, as he is bending forward, operates the four controllers without looking at them—concentrating on the action of his hook as it does the friendly act of lifting the heavy weight for his fellow-workmen on the floor.

PERFECT CONTROL.

Roaring along toward the end of the runway, I note our high speed and wonder if we are going to crash into the bumper; but no—we stop within a half inch of the bumper! I really believe that if my watch had been hung on the bumper, the crystal would have been broken without damaging the works. It was not a creeping stop either—it was not "inched" along until it got near the end, but it was one steady stop. It would have crushed an eggshell yet would not have spilled the contents.

I am going to take another ride on another crane—the one in the east bay of building No. 60, with Joseph Mead, who has been a hoisting operator for 12 years. His experience includes operating a clam-shell dredging bucket, a steam shovel and aerial cableway. For the past nine years he has been with the General Electric Company in various buildings, the last four years of which were spent operating one of the topmost, highest cranes in building No. 60—one of the most important jobs in the whole crane department.

The crane I now ride on handles 50 tons, and has done more in emergencies. The instant I step on this crane, I am told to sit down; that is because Joe has a job.

Joe takes me along down the shop, over the 60 foot boring mills, one of the largest in the world. I can see Walker Moat taking a cut on the exhaust base casting of a turbine, probably of about 35,000 kilowat capacity. We go on down the shop, where they are installing the largest planer in the world.

HEATING RIVETS

After Joe finished his last job he left the big hook close to Hathaway's boring mill. Then as we went down the hall it was necessary for him to raise the hook so as to clear a crane underneath us. Near one of the big planers is an oil blast burnace on wheels, which is used for heating rivets, and I wonder if they heat rivets as fast in Hog Island as they do in Schenectady.

We are above the iron floor and cannot go any further because the 100 ton crane ahead of us, operated by Stephen Pathea is lifting the base of a 20,000 kilowatt turbine. This is the base through which the exhaust steam passes.

Our next door neighbor, Steve, has now finished turning over the 20 ton casting and so Joe is going to take me further down the hall so that I can get a look at the hundred ton hook. What do you think a hook looks like that would lift 100 tons? The nearest way I can describe it is to say that it looks thicker than the thigh of a Roman gladiator.

Lights are beginning to twinkle here and there and the details of the picture far below me are becoming merged indistinctly into one blend. I must strain my eyes to distinguish the men below. Every moment the view becomes more picturesque, as more and more lights are turned on shedding a pinkish glow on the scene beneath us. The moving machinery has an added charm when shown up in the artificial light, and here we sit 66 feet, that is 6 stories, above the men at work. The span is 75 feet across, that is the rails on which we are running are 75 feet from each other instead of four feet, eight and a half inches, as they are on a railroad track. Going on further, I pass more turbines that are being loaded on a railroad car in the shipping section of the building.

LIGHTS GO ON.

It is six minutes after four and the big lights are turned on above us. As fast as Sam Herbert puts the parts of the turbines on the car, the shipping men box them up and brace them so they will arrive safely at the end of their journey, perhaps South Africa, Alaska or Japan.

Below us is a railroad train running through the building, propelled by a storage battery locomotive. It has brought in three

large castings from another shop. On we go to the end of the building.

Ed. Hathaways' boring mill is now running—working on the diaphram casting we delivered to him 35 minutes ago.

I noticed in Joe's cab, an overcoat from which the sleeves had been cut. Joe says that in the winter, he sometimes feels cold; but as a rule the upper part of the building is warmer than the lower part; and that the reason he cuts the arms off was so that while leaning forward to supervise the work below, he could have free movement of his arms with a sleeveless overcoat.

As the closing hour of 4:30 draws near, I have my watch in my hand to find out how quickly the sounds of industry begin to die away. It is now 26, now 27 minutes after four and the building is still in an uproar. Boring mills, and lathes are running full blast. Now the compressed air chisels have all quit their machine gun rat-tat-tat-tat; looking down I count five machines that are not running, and then the shrill blast of the 4:28 whistle pierced the upper atmosphere. Now I can tell a difference; one machine is gradually changing from a high, shrill note to a lower and lower and lower note, until finally it stops with a grunt.

Men are lining up in front of the time clock and the building is subsiding, just as the sea subsides after a storm, only far more rapidly. It is now 4:29 o'clock. If my hearing does not mistake, I can distinguish at least 20 different machines running.

Now the big boring mill just beneath me ceases to rotate; Hathaway's machine has been shut down; the dark forms of men are silhouetted against the sky-lights as they start for home. It is now 4:33 o'clock. Five minutes after the whistle has blown, and still the building sounds like fifteen blacksmith's shops.

Building No. 60 has a separate whistle of its own because it is so big; and so many different operations are going on in it that it has been found that the men could not hear either of the big whistles which reverberate from the hills miles around Schenectady.

And at the end of one of the most interesting days that I have ever passed in the General Electric Company, Joe runs the big crane up to the end, and unloads me and the Edison phonograph.

THE ORGANIZATION.

"Miss Edison" was delivered to the office of Mr. Giles by five o'clock, and the next morning I called on him to learn more about the work of his department and the men who lend so many helping hands to their fellow-men. In answer to my questions he gave me the following facts:

The crane department has charge of 250 overhead traveling electric cranes, 75 electric hoists, 70 elevators and two locomotive

The Big Four in the Crane Department, from left to right: John Harrington, Homer de Groat, George Benker and Jabez Giles.

cranes. This machinery is driven by 800 motors which must be kept in repair, and some of them are outdoors. The outdoor cranes are called gantry cranes, and they look like giant saw-horses, running on wheels and with an electric hoist running back and forth on the top horizontal girders. Sometimes the rails on which these wheels run are 125 feet apart. One of these cranes is so huge that it not only can, but actually does, raise

40 tons of iron or steel and carry it over the top of a two-story building which is situated between its tracks.

When cranes are in need of repairs, his staff rebuilds them; if heavier work is needed, they are replaced with larger cranes, but the old crane is preserved for use elsewhere at a later date.

Mr. Giles is a member of the Mutual Benefit Association and believes that practically every man in his department is likewise a member.

The department employs 320 men, headed by the following organization:

Jabez Giles, 15 years' service; Jack J. Harrington, 18 years' service; George Benker, 8 years' service; Homer DeGroat, 14 years' service; John Heigel, Sr., 19 years' service and Charles Harrington, 14 years' service.

The man with the longest record of service is Edward Tullock with 28 years' service. Ed. is a member of the quarter century club.

The department purchased $71,700 worth of Liberty Bonds.

CHAPTER IX

MULTI-SERVICE FROM COAL

UPPER END OF SCHENECTADY WORKS IS A GREAT ELECTRICAL BANK—A RESERVOIR FOR ESSENTIALS OF INDUSTRY.

The upper end of the Schenectady works is a great electrical bank,—a reservoir for heat, light and power. Taking first the electrical end of it only, the engines in building 13, the power plant at the Schagticoke Dam across the Hoosic River, the low pressure turbines in building 13 and the high and low pressure turbines in building 61 all feed into this reservoir, or it might be said, deposit electricity in this big bank.

Speaking electrically, there are three main outlets or three main checking accounts which draws away electricity: they are (1) light and power for the G. E. works and offices, (2) light and power for the Schenectady Railway Company, and (3) the light and power for the Schenectady Illuminating Company, which likewise is supplied from the G. E. electrical bank. All Schenectady's water is pumped by power from this "bank."

It is the intention to describe only the portion of the G. E. plant east of Mill Lane and comprising nearly 60 buildings; for these buildings are served with heat, light and power from No. 13, built in 1890, or 28 years ago. This is the heart of the upper Schenectady works. Here terminate lines from the hydro-electric power plants at Schaghticoke, 21 miles away, and here is delivered over one-third of the G. E. coal transported from western Pennsylvania, either on the New York Central via Buffalo or on the Delaware and Hudson via Scranton, a trip of about 300 or 400 miles.

In order to follow the processes in the sequence in which they occur, start with the coal at the canal bank and walk along with it and see what wonders it performs.

An endless chain containing 296 buckets not only conveys the coal from the canal bank to the power house, but delivers it in the storage bins, high above the boilers. The coal is automatically

dumped from the buckets into these bins without human hands touching it. The buckets are made of sheet steel—they do not wear out, but the sulphur in the coal eats them out in approximately three years, when they must be re-placed. The speed of the endless chain is such that every minute 18 coal buckets dump their contents into the overhead bunkers, from where it falls by gravity into the automatic stokers below. This conveyor is driven by a 10 horsepower motor. The chain itself runs north and south and turns six corners. Later on, what remains of this city, i. e., the ashes—is carried by another conveyor 1,000 feet along, which has 416 buckets and turns 10 corners. There are very few conveyors which run both north and south, east and west as this does,—the one endless chain passing under all the boilers. It also turns corners at right angles in order to convey the ashes to a hopper above the railway tracks where the ashes are dumped in a separate building to the west of the boiler house. It is another interesting fact that the wet ashes do not destroy these buckets of cast iron and with improvements recently effected, they probably will last for 20 years each.

INJECT COAL IN FURNACE.

Just as electric motors convey and hoist the coal and convey away the ashes, so also do they inject the coal into the furnaces under the boiler. There are 22 boilers totaling approximately 8,000 horsepower, the oldest of these being 28 years of age, and still delivering good steam.

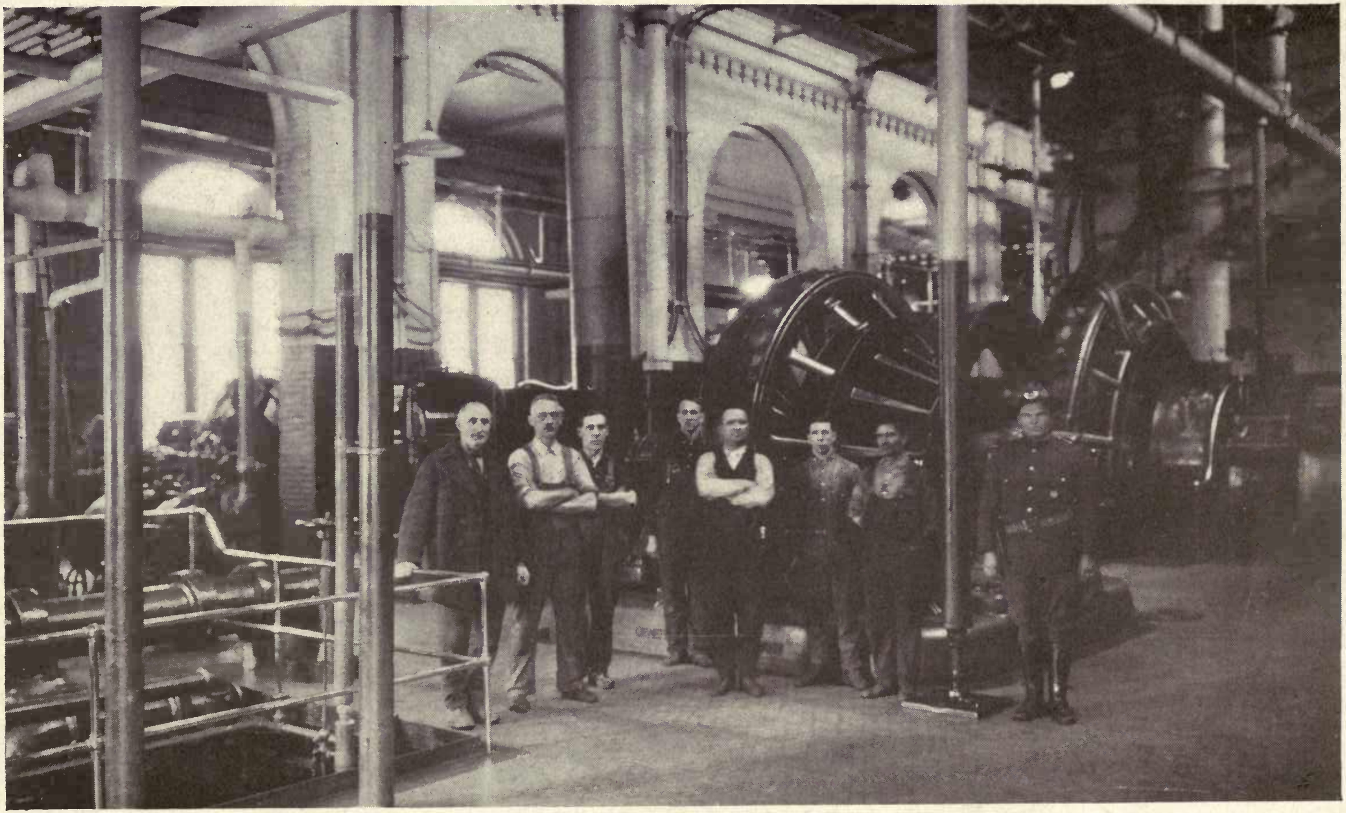
In 1917 building 13 supplied 375,000,000 pounds of live boiler steam for manufacturing purposes, and the older boilers carry 125 pounds pressure, while the newer boilers supply 160 pounds steam for the engines.

The speed at which things travel, increases from the coal pile to the switchboard.

The coal travels in the conveyor buckets at about six miles an hour. The steam races through the pipes toward the engines at 60 miles per hour.

The flywheels of the engine glide around at almost 80 miles an hour; and the electricity from the engine driven generators leaps out at about 180,000 miles a second—648,000,000 miles an hour.

The long aisle in the boiler room is of clean yellow brick; the



A Corner in Power Plant Building No. 13 showing the organization. From left to right: John H. Fryer, Wm. King, Jos. Plachta, Jos. Hines, Frank Flint, Cecil Gribbon, F. Brown, Louis Ryba.

warm red glow of the grates is not threatening or terrifying—it is agreeable and picturesque and the perspective ahead—the huge boilers towering on both sides, is quite impressive.

How different from the way writers of the past have described the stoke-holes of a battleship or trans-Atlantic liner. The stoker in this boiler room is an electric driven machine. The fireman never touches a shovel to the coal. He uses his brains far more than his strength. He watches the machine stoker, and occasionally turns the valves which allows the coal from the overhead bunkers to fall into the stoker . From here electric power rams the coal into the furnace. So the conveyor buckets and the automatic stoker work for the boiler and the boiler works for you and me.

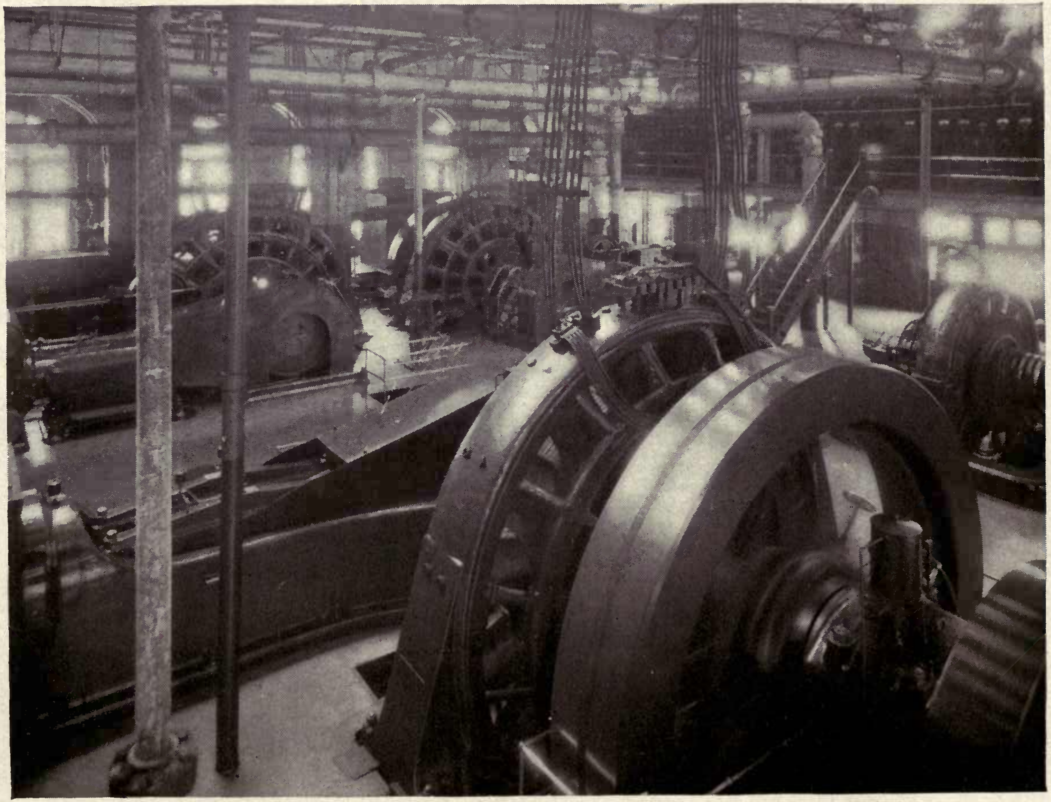
IN THE ENGINE ROOM

Into the three great engines dashes the steam from the boilers and the union makes electricity. But that is only telling part of the truth because the same steam only pauses here—it goes on and on and heats 50 other buildings.

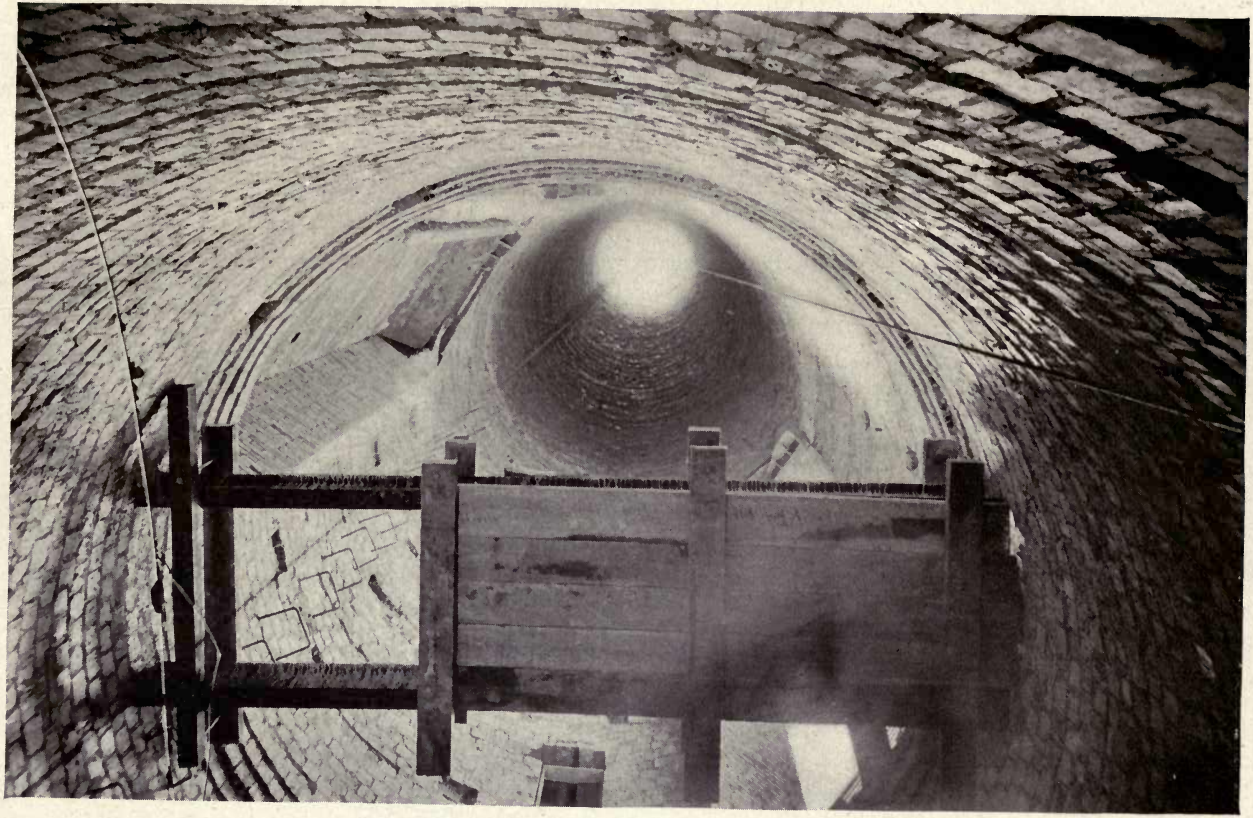
These three 1,500 horsepower engines have a wonderful history, and they also do a wonderful work. They are between 18 and 19 years of age, and they look as good as new. The fly-wheels of these three engines have *each* "traveled" more than 30 times the distance between the Earth and the Moon; that is, a point on the rim of *each wheel* has traveled that far. So you may judge from that, what good care they have had throughout their 19 or 20 years of life. And they are still going on and on in their useful career.

In this same room with the engines are four direct current turbine generators, some of which supply the station lights, others of which furnish electricity to the standardizing laboratory, because of the remarkably steady quality of the current which they supply—the exact type of electricity which the labortory demands.

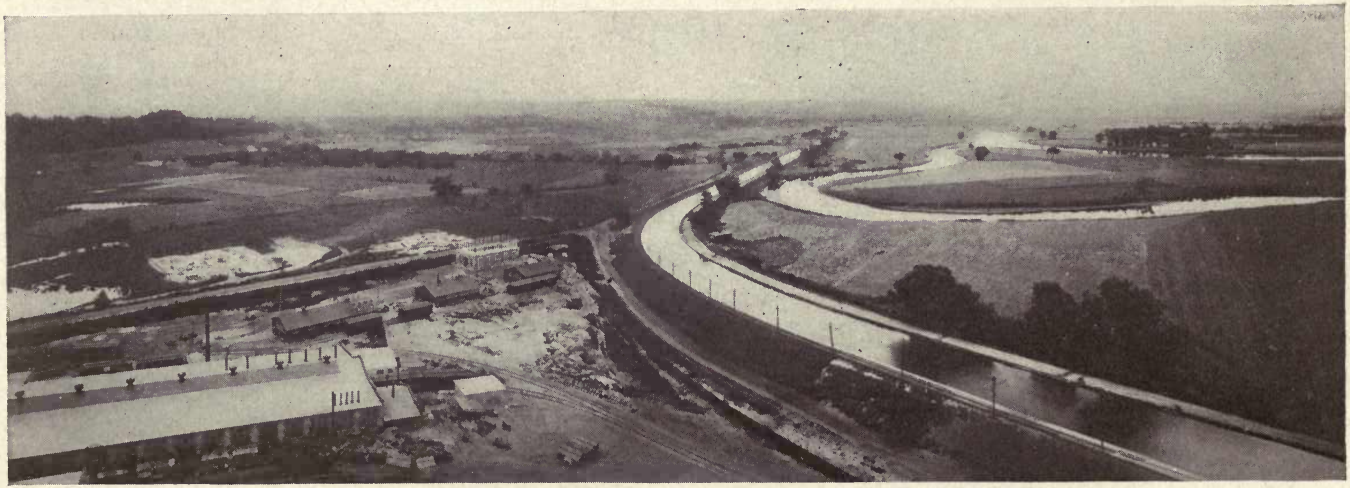
There are also six rotary convertors, aggregating 6,000 horsepower, 15 transformers aggregating 6,000 horsepower, one emergency engine driven direct current generator of 65 horsepower, and 125 feet of switchboard.



General view of Power Plant in Building No. 13. These three engines have done service for eighteen and nineteen years.



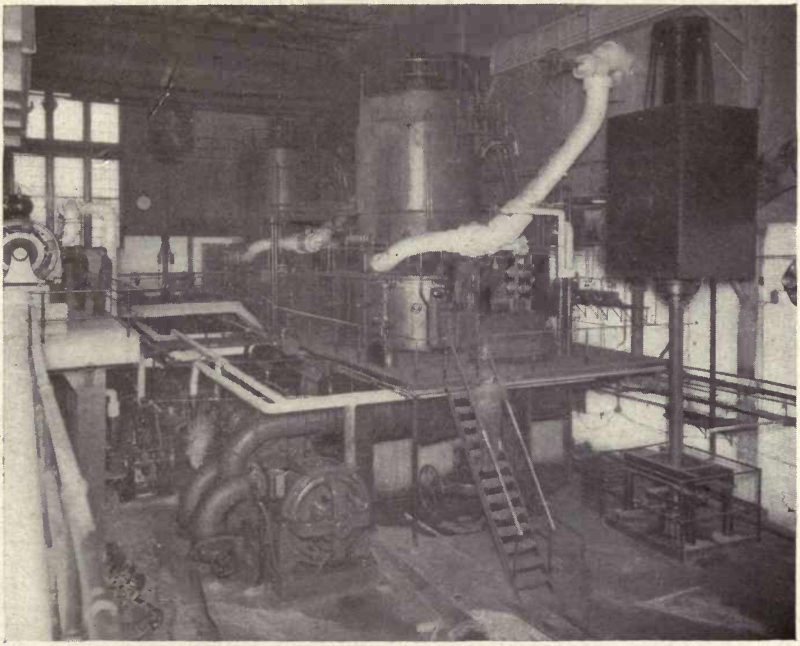
This is not a sewer nor an underground tunnel; but is a view looking upward through the stack at Power House Building No. 61. This stack is sixteen feet inside diameter, the inside circumference is practically fifty-one feet and the height of the stack is two hundred and ten feet.



Beautiful bird's eye view of the Mohawk Valley photographed from the top of the smoke stack of Power House Building No. 61. On the left is the General Electric Farm, and in the middle is the old Erie Canal, now taking a back seat for the State Barge Canal. To the right of the canal is the Mohawk River, and the war gardens are located still further to the right.

The oil is used over and over again. It is strained and cleaned and filtered. They don't even waste the waste in this power plant, as it is washed in steam and water and then dried in a centrifugal electrical dryer the same as is used in laundries.

And upon the roof is that faithful servant called the steam whistle. For 28 years this whistle has never had a penny spent



Two of the large vertical steam turbines in Power House No. 61. After the steam has been used for power, it is available for use for heating scores of buildings.

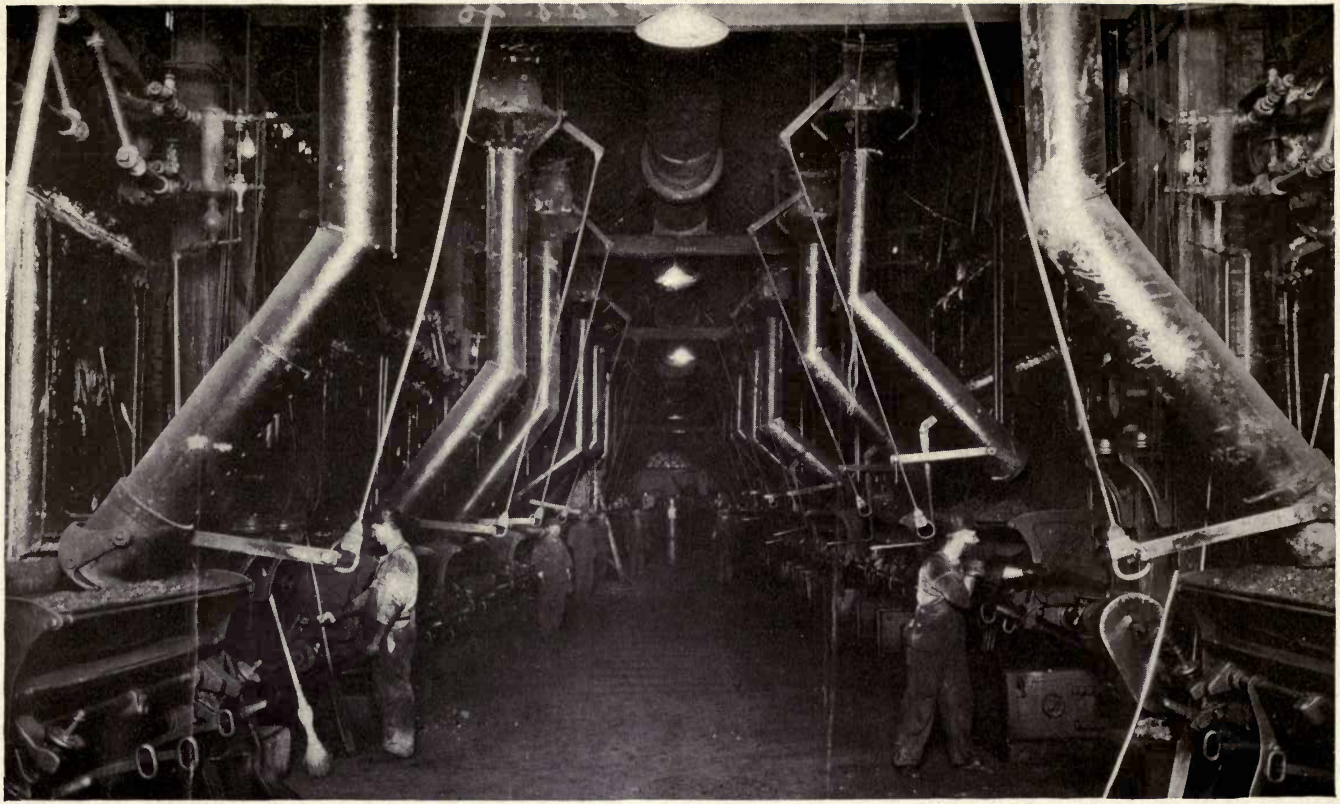
upon it for repairs, and it has only been painted once, and that was not necessary, because it's made of brass. It now blows at 6:55 a. m., 7 a. m., 12, at noon, 12:25 p. m., 12:30 p. m., 4:28 p. m., 8:25 p. m. and 8:30 p. m., and at 1 a. m. and 1:35 a. m. for the night workers. The average blast is approximately 10 seconds. Neglecting emergency whistling, such as blowing for big fires etc., and averaging eight blasts daily for 28 years, the

whistle has blown an equivalent of nine days, day and night, 24 hours at a stretch without stopping. Think of the service which it has rendered to us; and how obedient we have been to its call.

Building 13 is 114 feet wide and 340 feet long. At the extreme northern end is one of the prettiest engine rooms imaginable, with red painted cement floor, competing with immaculately clean tile, burnished brass and polished steel, which is a delight to the eye of anyone who might be called a machinery connoisseur. In this room the machinery literally fills the building. To the observer it would appear that there was hardly a square foot of space that was not effectively utilized. On the right is a giant 6,000,000 gallon cross compound pump which has run night and day for 17 years. Beyond is a 3,000,000 gallon Deane pump which has run night and day for 26 years. These pumps supply the water used in the Schenectady works.

On the other side of the room is where the power plant engineer with a liking for thermo-dynamics derives the greatest inspiration. For it is here that is found one of the finest examples of skillful power plant engineering that exists anywhere—i. e., the low pressure turbines. These come as near "getting something for nothing" as can be imagined; for they generate a maximum of 4,000 horsepower out of steam heat which for years and years in the engineering world was considered almost valueless for power.

After the steam has given its impetus to the pistons of the three engines which drive the big electric generators, it passes into the heating system. In the winter, all of this steam is used to heat 50 buildings at the upper end of the works. That is, all of it is used on the coldest days. In the hot days of summer, none of the exhaust steam is used for heating the buildings and then the low-pressure turbines utilize the heat in this steam which has already made electricity once. This steam is sent to the two 2000-h.p. turbines at the northern end of the building where this steam again makes electricity. You might say the low-pressure turbines utilize the energy which has slipped through the fingers of the big engines at the end of the building; for they reclaim a total of 4000 horsepower.



A remarkable picture of a boiler room showing the automatic stokers installed in Building No. 13. From left to right the men are: Adam Canyo, John Kiskiel, John Gingston, D. Pistello, F. Sansouci, W. Pruszowski, and J. Poterak. This boiler room has a capacity of 8,000 HP, and some of the boilers are seventeen years old.

To assist these low-pressure turbines in conserving this 4000 horse power there are two motor-driven, dry vacuum pumps, two motor-driven hot well pumps, two motor-driven circulating pumps, two steam-driven step bearing water pumps, and two steam-driven oil pumps. To help to keep all these machines in repair an overhead crane is installed which can lift the heavy burden when the machines must be opened up and repaired internally.

As a study in by-products, Building No. 13 offers a wonderful example. The steam which is first used for making electricity in the engines is again used for heating the buildings, and any surplus which may exist makes electricity once again on the low-pressure turbines. But still there is another by-product, the condensed hot water which is pumped from the radiators back into the boilers so as to save the heat which even remains in this.

The following facts show work done by Building No. 13 power plant during the year 1917:

Electricity generated, 17,000,000 kilowatt-hours.

Coal consumed for heating buildings, for manufacturing purposes, and for making electricity, 63,000 tons.

High-pressure steam (at 125 lbs.) for manufacturing, 375,000,000 lbs.

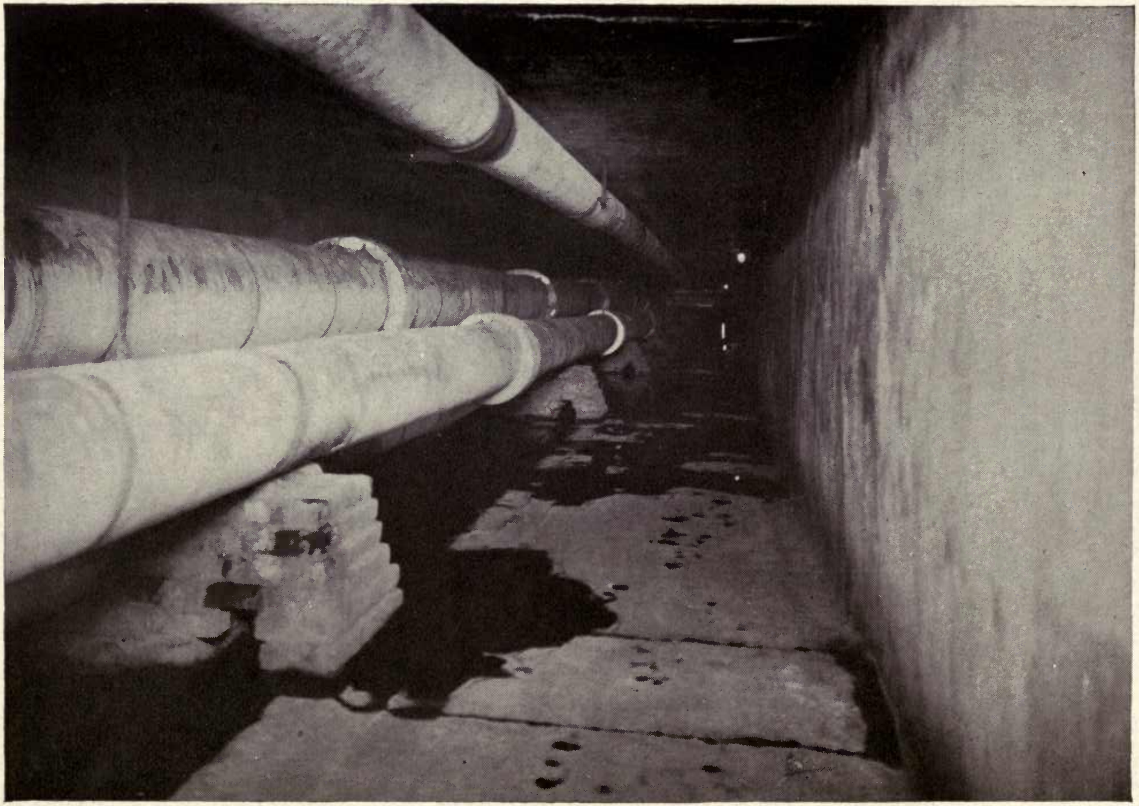
Pounds of water evaporated, 1,158,000,000 lbs., of which 88,000,000 lbs. were used to operate a 9,000,000-gallon pumping plant.

Heating surface supplied in radiators and pipes 230,000 square feet.

It would be interesting to have some engineer figure out how much coal would have been burned if all the buildings had been heated with live steam direct from the boilers, and the same amount of electricity generated, an equal amount of pumping done, and the same amount of live steam supplied for manufacturing purposes. And this latter item is very large and important for almost half as much steam is used for cooking, drying, and boiling, as is sent through the engine, and then on to either the radiators or low-pressure turbines.

LONG SERVICE MEN IN BUILDING THIRTEEN.

Name	Years of Service.
A. W. Nisbet	14
J. H. Fryer	32
J. F. Martin	31
William King	28
G. Bittner	28
J. F. Bliss	29
F. Bunk	24
H. Bradt	23
J. H. Schermerhorn	22
D. H. Pfieffer	22
J. Waggoner	22
J. Demsham	22
N. Claflin	20
E. Conyo	20
M. Brown	20
B. L. Butt	18
William H. Ringe	17
Frank Flint	17
F. Sansouci	16
William S. Borst	16
C. Zickler	16
J. Gingste	12
B. Zanotti	12
D. H. Alvord	12
A. Folke	12
P. DeFulvis	12
A. Kania	12
William Engel	11
P. Kirwin	11
Jos. Hines	11
G. Cross	8
D. Piscetelo	8
J. Washeleski	8



This subway is 7 feet high and 12 feet wide, and extends for almost a mile under the main avenue of the factory. It is illuminated and ventilated by electricity and the pipes carry different kinds of steam and compressed air. As the pipes expand and contract with the heat and cold, they move back and forth on rollers and telescope within themselves by means of expansion joints.

CHAPTER X

THE SUBTERRANEAN LABYRINTH

VAST SYSTEM OF TUNNELS AND PIPES—SEWAGE UNDER PRESSURE—HEAT ENOUGH TO WARM LARGE PART OF SCHENECTADY — RIVER OFTEN SEVEN FEET ABOVE LEVEL OF WORKS—MANY VARIETIES OF ELECTRICITY CARRIED IN CONDUITS.

Few who walk along the street of the General Electric works realize that under their feet there are pipes containing hydrogen, others containing oxygen, and still others containing acetylene, fuel oil, illuminating gas, and even varnish. Compressed air flashes the mail bags underground between building 2 and building 56 at express train speed. There are pipes for two kinds of air; pipes for four kinds of steam; pipes for four kinds of gas; others for five different water distributing systems at various pressures; and conduits for electric wires which carry electricity at six different voltages; and to cap the climax, the fuel oil is piped underground all through the works instead of being transported in motor tank trucks.

SPECIAL OIL SAFETY VALVES.

Special safety valves shut off the supply of fuel oil to any buildings in case of fire in that building. The way the oil is burned, sometimes with the aid of steam and sometimes with high pressure air, how it is stored and distributed is a story in itself.

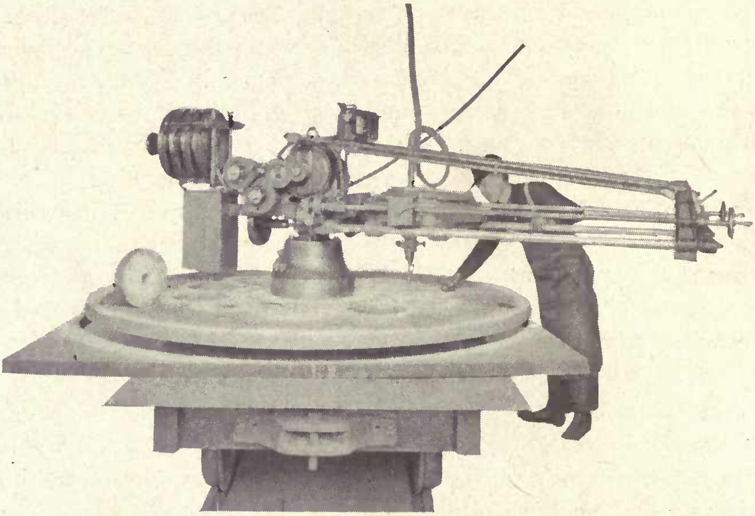
VARNISH TOO.

And then varnish is also piped underground. The varnish plant, the tanks and building 67 are all interconnected by pipe lines.

The oxygen and hydrogen are made out of water by electricity. Twenty wonderful machines in building 12 annex, generate these gases and the chemical energy forces them into great steel tanks outdoors. Other machines make acetylene out of calcium carbide. Then pipes convey these gases to six buildings, where they are used for cutting and welding iron and steel. It is a wonderful sight to see a thin blue flame of oxygen and hydrogen cutting

through a 14 inch steel plate "as fast as if it were cheese," as one man put it. The art of the chemist can cut steel faster than the the most powerful machines in buildings 16 or 60.

In building 8A there are 12 oxygen-hydrogen cutting machines. Some of these are portable, and the overhead crane picks them up and gently sets them down on top of the steel which they are to cut. An electro-magnet in the foundation of these machines is then supplied with electricity, and "presto"—it clamps the machine to the work, thus doing away with the need of foundation bolts. The power of electricity is here used to make a vice-like grip.



By means of these machines the gases " cut steel like cheese " and faster than the most powerful machine tools known. Oxygen and hydrogen replaces machine tools, and circular discs are cut rapidly from plates of steel.

In this steel cutting the pressure of the oxygen varies from 20 to 110 pounds a square inch. These variations are made to accommodate different cutting speeds and the cutting speeds vary with the thickness of the metal and the radius of the cutting circle.

Another unusual and unexpected use of hydrogen is for reducing the oxidization in the Tungsten furnaces in building 5, the research laboratory.

Hydrogen and oxygen are also used in buildings 4, 8, and 37. In buildings 10-C, 8 and 8-A, they weld by acetylene and oxygen. The steel bottoms are welded to the sides of great steel tanks—"as tight as if it had grown there," and broken cast iron flasks from the foundry are repaired also in this building by this spectacular chemical welding process. Hydrogen also preheats the metal before the welding starts.

Illuminating gas is also piped throughout the works in iron pipes buried in the ground.

MANY KINDS OF WATER PIPES.

There is a hydraulic main which carries water at 2,400 pounds pressure a square inch. This is used in six different buildings where the hydraulic presses force the armatures on to their shafts, and for other jobs where immense pressure is needed. The water is pumped by an electric pump in building 64-A.

Then there are the mains for supplying water to the 145 outdoor fire hydrants, to the 1300 indoor fire plugs with hose reels attached, and to the 75,000 automatic sprinklers.

Other pipes supply the factory water to 200 buildings where it is used for manufacturing and toilet purposes; and there is a complete and separate system for supplying drinking water to 275 drinking fountains in all the buildings.

But this is not the whole story—there are two other water systems for supplying the condensing water to the power plants. This condensing water creates a vacuum in the condenser which doubles the amount of power produced by the steam turbines.

Then, there are hot water pipes which bring the hot water back from the radiators and return it to the boilers so as to conserve not only the water but the heat in it.

There also is a big pipe line from building 260 along the canal bank and under the old Erie Canal to the "Grid Iron" water-system. In building 260 there is a pump which takes water from the old Erie Canal and forces this water through the system into the tanks, up in Bellevue.

Few know that the old Erie Canal is filled by a pump in building 255, located near the Schenectady city pumping station.

SEWERS.

There are two types of underground pipes which might be called sewers, but which contain the discharged water of the plant under pressure. Some of these pressure pipe lines containing sewage, run out of building 28, where electric motors operate the lift pump, and pump it to the city sewer main. These pumps force the sewage through the mains under pressure and eventually it goes to the disposal plant beyond the Locomotive works. A small portion of the sanitary sewage system flows by gravity to the city sewers.

Another sewer system is provided to carry away the storm water which flows through two large mains to the Mohawk River. In time of high water when the elevation of the river is approximately seven feet above the level of the floors of the works, the valves of these two mains are closed, and large pumps take the water from these mains and force it through bypasses around these valves back to the main which discharges into the river.

ELECTRICITY.

The electricity of this vast plant is all distributed under ground. Electric cables are covered by lead and are dragged through specially made clay conduits, buried under the streets. Alternating current electricity is distributed at 10,000 volts and 550 volts; while direct current electricity is distributed at 500 volts, 250 volts and 125 volts. This is in addition to the 101 different kinds of special "made to order" electricity which the testing department produces by itself; for it has 140,000 H. P. of apparatus.

TELEPHONE SYSTEM.

Also, under the street of the General Electric works is a huge telephone system. It has recently been enlarged by the installation of a six hole tile conduit, through the larger part of the plant. These conduits or ducts are so arranged that large cables containing as many as 1800 wires to a cable, can be drawn through. This has increased the telephone system materially.

Under building 93, there is also a subway for the distribution of high and low pressure air, high and low pressure steam, fuel oil, and illuminating gas. As a rule gas and oil are not permitted to be run in a tunnel but these pipe ducts are so arranged that in

This little building contains the ventilating outfit which keeps pure air in the tunnel under the main avenue. The vapor which is being expelled from the exhaust hood has been sucked from the pipe tunnel and expelled into the air. Thus those who repair the pipes have their health preserved.

case of fire the fire can be readily extinguished by removing plates from the tunnel.

The department of grounds and buildings has separate maps for each of these underground systems. A map for oil, water, air, various gases, fire protection system, drinking water, etc. If all these different complete systems were to be crowded on one map it would either be hopelessly confused, or of such immense size that it would be impracticable to handle it.

THE G. E. PIPE SUBWAY.

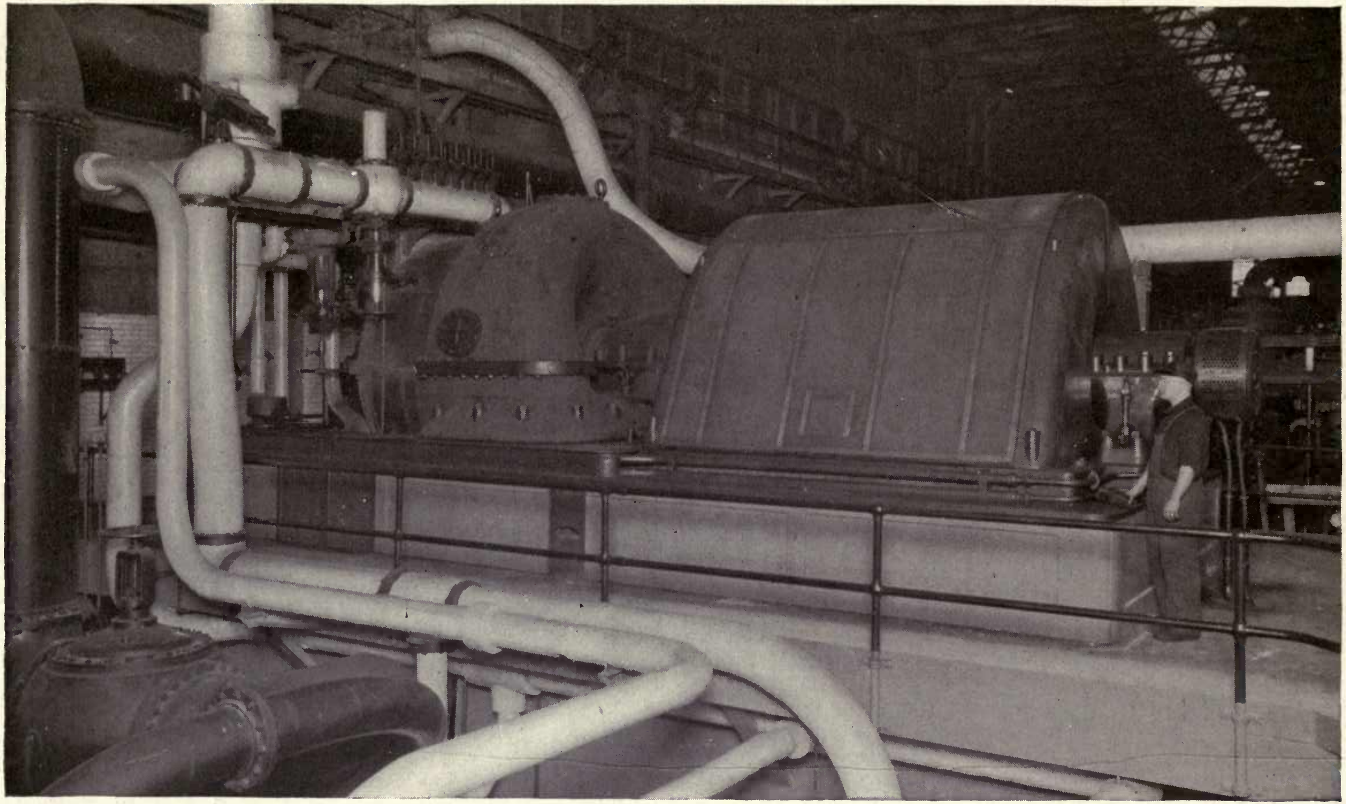
The General Electric Works also has a subway. This subterranean pipe passage for much of the distance, is seven feet high, almost 12 feet wide, and the bottom of it is below the level of the canal. It is ventilated and illuminated by electricity, and pumped dry by steam pumps.

The next time you walk down the main avenue, when you get near building 52, notice the little structure opposite it, and on the right, with the ventilating hood on top. It is building 53-A, and is the outlet of the ventilating system of the subway. For years it has been expelling the hot damp air from the subterranean passages so as to make it more healthy for the men who keep these pipes in repair.

MANY KINDS OF STEAM.

This underground passage is for the steam and air pipes, and it is a revelation how many different kinds of steam are used in the Schenectady works. One pipe in the subway conveys steam at 180 pound pressure. This is a 12-inch pipe, which supplies steam to building 60 for testing turbines. The steam comes from the boiler house in building 61. A duplicate of this pipe is likewise buried in the ground encased in tile, thus making doubly sure the supply of this steam to building 60.

The other kind of steam is the 125-pound manufacturing steam which is carried in a 10-inch pipe extending from building 13 to building 93. It is nearly 3-4 of a mile long and is tapped in many places. This steam is used for cooking and drying and other manufacturing purposes. The boilers which deliver steam at 125-pound pressure are those in building 13, and in the



One of the big 10,000 KW steam turbine generators in Power House Building No. 61. A beautiful job of steam fitting that gladdens the eye of electrical as well as mechanical engineers.

destructor plant in building 80. At the lower end of the works, owing to radiation of heat and the condensation of some of the steam in this long pipe, the pressure is sometimes reduced. To provide against this, there is a "booster valve" which automatically opens whenever the pressure reduces, and allows high pressure steam from building 61 to reinforce, as it were, the steam which is being brought from building 13.

HEATING STEAM.

Also in this subterranean passage there is a large 20-inch pipe carrying low-pressure steam for heating the buildings.

This main, almost seven-eighths of a mile long, runs from building 2 to building 93, with a dividing valve at Mill Lane. The engines in building 13 and likewise the two turbines in building 61, furnish exhaust steam to the heating system by means of this great artery.

But there are other than steam pipes. There is also a 10-inch pipe which transports the compressed air for driving air motors, pneumatic drills, etc., at a pressure of 80 pounds a square inch. The main air compressors which feed air into it are in buildings 7, 49, 60, and 61.

WATER USED AGAIN.

Running from building 41 to 93 is a 10-inch hot-well line which carries water back to building 61, where it is again used in the boiler. The heat which it contains is thereby conserved.

Not the least surprising thing about this tunnel is the way the pipes are either hung or supported on rollers. Some are hung from the ceiling, yet supported on rollers; some from the side of the tunnel on brackets, but still resting on rollers; while others are supported by brick piers, with rollers interposed between the pipes and the piers. The rollers allow the pipes to travel back and forth as they expand and contract with heat or cold. All the pipes, even the air pipes are so provided. In addition to the rollers there are also "expansion joints" which are likewise necessary to take care of the expansion. An expansion joint is a telescopic arrangement similar to those which can be found on any big steel bridge, for the girders in a bridge likewise expand and contract with change in temperature.

UNDERGROUND PUMP.

A certain amount of surface water gets into this pipe subway, and so there are provided several cisterns or "pump pits" where it flows by gravity. From these it is pumped by a clever arrangement of pipes and valves, by which one pump keeps all of these different cisterns empty.

In another tunnel leading into building 61 is a 30-inch low-pressure steam pipe. This joins the long subway and so supplies steam to the lower end of the works. This large pipe comes from the two vertical steam turbines in building 61 and takes out steam from between the second and third stages. Thus the steam comes from the boiler at 180 pounds pressure, and, after being used in the first two stages of the turbine, it can again be used for heating the buildings. When these turbines were visited early in December, only one of them was running, drawing 128,000 pounds of steam an hour from the boiler, and supplying 70,000 pounds of steam an hour to the heating system, at a pressure of 35 ounces; and the rest of the steam going into a condenser carrying a 28 1-2 inch vacuum. Thus the turbine was serving the heating system with exhaust steam and yet operating condensing.

The longest run of high pressure steam pipe is from building 13 to building 109, or close to a mile. The two longest runs for low pressure steam are from building 61 to the lower end of the works, and from building 13 to the Dock street buildings.

Building 80, which is the destructor plant, also makes steam for manufacturing purposes, in two 240 horsepower boilers and feeds it at 125 pounds pressure into the mains.

THE HEATING SYSTEM.

The radiators and pipe coils which heat the Schenectady works have a total surface of 550,000 square feet. It is an interesting coincidence that the total number of square feet of floor surface in the works is 5,500,000 square feet; thus the radiating surface is just 10 percent as great. So the general average is one square foot of radiating surface supplied for heating, for every 10 square feet of floor surface; but this average could not be followed as a rule for designing the heating system of any single building.

If all the radiators and pipes used for heating were in the form of a 1 1-4-inch pipe it would be about 220 miles long.

This amount of heating surface installed in residential steam heating systems would warm 1,374 two-family houses of the type most used in Schenectady; that is 2,748 homes could be heated by the steam which heats the General Electric works. According to the estimate of the city authorities, there are 12,000 houses in Schenectady.

CHAPTER XI

THE GIRLS' PART

HUNDREDS ARE EMPLOYED IN BUILDING SEVENTY-SEVEN —THEY MAKE ELECTRICAL SOCKETS, SWITCHES, ETC. —COMPANY PAYS SPECIAL ATTENTION TO KEEP SHOP AN IDEAL WORKING PLACE.

Girls, girls, girls, pretty bright eyed girls to the right of you, industrious nimble fingered girls all around you—600 girls, all busy helping Uncle Sam. If you ever have the opportunity of going through building 77, take an adding machine with you to count the millions of delicate, finished parts which the girls manufacture, install, adjust and test before being sent out to light the army camps here or the trenches in France. For the most of their work has to do with lighting.

When you reach up to turn on an electric light, look more attentively at the efficient socket which brings you so close (and yet so safely) to the Twentieth century genii—electricity.

It was a girl who made this socket, or rather 207 different workers, mostly girls, handled the various parts and conducted the 237 different operations necessary to make up one ordinary blackkeyed socket. And they make 5,000,000 annually!

In the early days when Edison was introducing electric light, just a little over one generation ago, only the experts dared to handle electricity—but now a babe in arms could start and stop a big machine, or flood an auditorium with light.

And if you are in doubt whether girls can operate machinery in a big factory, here is where you will find out your mistake. Not only do they operate wonderful machines that press, stamp, draw, punch, drill and thread brass and copper; but there are hundreds of operations which require the utmost skill and dexterity, and where the supple fingers of a girl are really superior to those of a man, whose "fingers are all thumbs"—for work of such minute character.

When you see a girl solder a wire in one of the 7,000,000 fuse plugs made yearly, you will begin to believe that the hand is

Girls in Building No. 77 using the electric screw drivers, six hundred of which are in use driving millions of tiny screws into electric sockets and switches.

quicker than the eye, for she will do a score or more of them in the brief time you stand by her side.

In this model and modern concrete building with high ceilings and large windows, the air is as pure or purer than in a New York hotel dining room, despite the fact that they are melting solder and sealing wax with electric irons and are operating hundreds of machines which are lubricated by oil.

So ingenious are these processes, and so wonderful is the building in which these 600 girls work, that recently a moving picture was made setting forth as only the screen can, the skill and the dexterity of the nimble-fingered girls, their surroundings, the safety provisions which make it impossible for them to get hurt, and other features that only an inspection trip would bring forth. Seven hundred theater audiences comprising 85,000 people have already seen the film.

The film is called "Fairy Magic," and symbolizes the almost magical way in which the tiny pieces are assembled by the quick-witted girls.

The girls make 600 different kinds of sockets. Beginning with the moulding of the porcelain base, the film shows how a handful of carefully prepared clay is laid under an automatic press and at one stroke of a wonderful machine, there emerges a finished porcelain socket base ready for the baking kiln. In this building 25,000,000 pieces of porcelain are installed in electrical devices yearly.

Some of these punch presses instead of pressing porcelain, stamp out the metal caps.

The threaded socket shell into which the lamp is screwed which you use every day, is rolled in a fraction of a second. You can see this thread every time you screw or unscrew a lamp into a socket.

Just as if you were going through this great building, you can see these shells dipped in potash water to rinse the grease off of them; see the bottoms punched out of them to make a passage for the wires; see the prettily grilled socket cap struck out of sheet brass at one stroke of a machine, and see a score or more holes punched all around the side of the cap by another automatic machine. These machines also are safe so that no one can be injured in operating them.

An electric soldering iron in a fixed position melts the sealing wax used in a key switch. The ventilating hood sucks the fumes from the melting sealing wax out of the room.

And then the revolving portion of the machinery is protected by screens and other metal drill work so as to make it impossible for a girl to even catch her hair in the machinery. As one girl put it—"Everything that is moving is protected and everything that is not protected is not moving."

Automatic steel fingers take the caps out of the machine which has threaded them, thus making it unnecessary for a girl to insert her fingers anywhere near the danger zone. The moving parts are so carefully encased that it is doubtful if a girl could get hurt if she tried to do so—and the girls in building 77 are too sensible to try any foolish experiments.

At some of these machines the girls stand at the opposite sides of a revolving table from the machine which does the work, so she is easily several feet away from the working parts of the machine although she is feeding it.

Three at a time the cups for the outside shell of socket pour out of one of the machines operated by men. Then the audience can see the forming of the cups and the trimming of them, how they are headed so as to support the shade-holder in your dining room or on your reading lamps; incidentally, both ends of these are trimmed at the same time, thus dividing the time in half. Every year 2,500,000 lbs. of sheet metal and 2,500 miles of metal strip is used.

Then after seeing these things, we are shown a socket in the five different processes or steps of manufacture.

In the old days men used to hold the metal part against a buffing wheel, but here the audience sees how automatic machines do this so the men do not have to get within two feet of the buffing wheel; thus they can polish the brass sockets to a nicety, and yet avoid the metal dust.

And then the notch through which the black rubber key passes, is punched by another safety machine operated by another girl, whose hands move with lightning-like rapidity. Machine after machine is guarded with iron-work, almost resembling the cage in which the bank teller works.

You perhaps do not know that in every socket there is a little horseshoe-shaped piece of brass, and this is fed automatically into the presses which bend it into the proper shape.

Think of girls handling thousands of these pieces every day,

When a new socket, switch or other electric device is designed it is first built in hard wood in this model room. Here also some switches are tested; and some are operated "on and off" four hundred thousand times before they break. From left to right there are four men: 1 — Frank C. De Reamer, 2 — Gustav Butzke, 3 — Emil Stahl, 4 — Julian Charles Tournier.

tapping the holes and driving the screws into them by automatic machinery.

And then the second reel of this picture carries the audience further into the details and intricacies and marvels of making an ordinary everyday electrical socket. Who would ever dream that such a simple thing as a socket should require thousands of dollars worth of expensive machinery and 237 different operations, carried on by the 207 employes necessary to fabricate!

Building No. 77 where almost 800 girls make electrical devices. Note the large window space and the high ceiling, by comparing with the height of the automobile at the left.

In order to appreciate the delicacy of the work, the picture shows that some of the parts are much smaller than a dime. Into these parts screws are driven, and soldered connections are made.

In the same building, 3,000,000 screws are made every week and 1,500 miles of wire are used yearly. Every week 2,000,000 of these screws are inserted into the electrical devices by electric automatic screw drivers. Some of these processes in the manufacture of screws are carried on at a speed of 120 a minute, or

It requires two hundred and fifty girls to make one electric socket. The cheaper sockets can be made and sold, the more will electricity be used to emancipate the human race from drudgery. Economy of production is accomplished by good organization and not by sweat-shop methods.

two every second; and the whole screw is only two-thirds as long as a dime is wide.

There is hardly a citizen in the United States, man, woman or child, but what has at some time in his life used a screw-driver on a screw, and here is an opportunity of seeing how the slots are cut in the screw heads, about two every second. And how do you suppose the threads are put on a screw? They are cold-rolled! They are not cut, but at about the rate of one every second they are rolled through a machine and shot out of the far side finished and perfectly threaded, ready to be installed into a socket for your home.

And then you see how the black keys and their stems are manufactured by the million; and possibly the new electric socket which you bought last week was made only three days before right here in Schenectady! One machine operated by a girl, makes but one movement and 25 keys are created—thoroughly insulated and safe—all at one stroke of the machine!

And then the assembling. The making of a socket begins with a porcelain washer; into it contacts, screws, punchings, etc, are inserted and attached with lightning-like rapidity. And right before your very eyes you can see this socket grow larger and larger until it begins to attain the form in which you are accustomed to see it. One by one the nine parts of a socket are put in place by the deft fingers of some bright-eyed girl and you can see how the screw-heads are insulated by sealing wax from an electrical heater. The audience is shown the exhaust which sucks the smoke from the sealing wax up into a pipe to be electrically ejected from the room.

And then another machine puts a fibre lining inside the brass cell and if you examine the socket more closely the next time you turn on the light you will see it just peeping out from under the edge of the brass.

And then, finally, you see a completed socket. One of the 5,000,000 turned out annually in Schenectady alone.

One girl wraps thousands of these sockets every day—her fingers move so rapidly that the moving picture camera can scarcely keep pace with her as she neatly packs them in the paste board boxes. Every year 2,000,000 boxes are used

and these are made by automatic electric machines which use up 600 tons of paste board.

Most of the screw driving is done by electricity; and

Girls using safeguarded punch presses to stamp parts of electric sockets out of sheet metal. The machine does not operate until the lever is thrown down into a horizontal position, and then the wire netting stands between the girl's hand and the moving part of the machine.

there are over 300 of these power driven screw drivers which are operated by the girls. The principal feature is that they are auto-starting and auto-stopping. The screw will not begin to rotate till the girl has brought the work up in contact with the

screw driver; and after the screw has been driven home, the driver ceases to rotate through the operation of what is known as a "slipping clutch."

VENTILATING SYSTEM.

In walking through building 77 you are impressed with what looks like a mile of ventilating pipes. These pipes expell the dust, smoke and the odors from the melting solder and sealing wax. The ventilating system connected with these pipes are motor driven and you can gain a new appreciation of electricity, when you see little motors scarcely bigger than a quart bottle, which are faithfully protecting the health of these hundreds of workers. When you look at the hood over one of the electrical sealing wax melters which is in operation you will see there is no smoke whatsoever being released in the room. In fact, it is sucked up so rapidly into the pipe that unless interested, you would not know there was any smoke created at all.

Most of the soldering irons are permanently fixed for melting sealing wax. Thus, the girls as a rule do not have to handle these heavy irons; but in a few places this kind of iron cannot be used; and here the weight is carried by a spring—taking advantage of the well-known fact that if the strength of the operator is saved, the fatigue is lessened and hence inaccuracies are minimized.

ARE THEY PATRIOTIC.

The employes of building 77 subscribed $68,000 to the fourth Liberty loan. This is in addition to $48,000 for the third, $27,000 for the second and $25,000 for the first. A total of $168,000. And on top of this up to last Fall the employes had purchased over $3,000 worth of thrift stamps.

In the buildings are 450 members of the mutual benefit association, by which health, life and accident insurance is obtained for an average of nine cents per week.

Did you know that before a new socket or switch of the kind you use in your house is finally designed, that it is first built by experts in wood—hard wood? This is done in the model room, where you can see Mr. Stahl, Mr. Butzke, Mr. De Reamer and Mr. Tournier who are carrying on some investigations. They test all of these socket switches and sometimes make a

How infinitely better than ''sweat-shop'' conditions or ''tenement house production''! Although the building is made of concrete and equipped with automatic sprinklers, fire hose, etc., fire drills are held at irregular intervals.

switch go through its "off" and "on" operations a quarter of a million times!

Below are the names of the employes in building 77 who can boast of continuous service for over 25 years:

Barron, Fred A., 30 years; Beuth, Charles, 29 years; De Reamer, Frank C., 26 years; Fransen, Carl A., 31 years; Koch, T. L., 29 years; Luther, John E., 27 years; Mackintosh, Fredrick, 28 years; Nevins, Mrs. Nora, 27 years; Pausch, Charles, 37 years; Pross, John, 30 years; Sargent, Howard R., 26 years; Schwab, Henry, 30 years; Stigberg, Leonard, 28 years; Tournier, Julius, 37 years; Ward, Duncan C., 32 years; Watt, William S., 27 years; Wicks, J. B., 30 years.

Thus the members of the Quarter Century Club who are in building 77 alone, have worked continuously for 504 years.

Below is the organization of the Wiring Supplies Dept. in building 77:

H. R. Sargent, T. Moore, J. R. Byrne, J. B. Wicks, W. C. Kelly, J. J. McCann, F. B. Ennis, F. W. Fagal, J. Ridley, C. Fransen, H. J. Hambrook, F. J. Goetz, E. H. La Vey, J. Goodrow, W. D. Simpson, F. Rodgers, W. Kratky, L. Rytchie, W. H. Phillips, A. F. Bartlow and G. Greenwald.

CHAPTER XII

THE PEACE CELEBRATION

EYE-WITNESS TELLS OF STIRRING SCENES AT SHOPS WHEN PEACE NEWS COMES—SWEETHEARTS WEEP FOR SHEER JOY AS ORGANIZED MOB GOES INTO ACTION.

I was just coming out of the lower restaurant of the G. E. works at 12:45 o'clock yesterday. It struck me as peculiar that the great whistle on building No. 13 should be roaring at that untimely hour, and I had no sooner stepped down from the restaurant entrance than I saw crowds of men and girls—without hats—all looking to the east.

"What is the excitement?" I asked a man nearby, thinking that possibly there had been a runaway or some kind of an accident. He replied, "They have passed the word down the line that the war is over and that Germany has accepted our terms."

Only later did I appreciate the speed with which word of mouth speech spreads like wildfire down the main avenue almost a mile in the few seconds just passed.

Then I saw a man with a flag. Little did I imagine then that within 10 minutes there would be 23,000 flags waving along the main avenue.

But still the whistle roared and I walked down toward the main gate, joining the ever increasing migration of hatless men in overalls, with the grime of the shop still on their hands, touching elbows with girls in bloomers and aprons, while every window high above my head on either side was thronged with eager, inquiring faces. I walked on, wondering and hoping and praying that the report was true. Soon I realized that a great scene was being enacted.

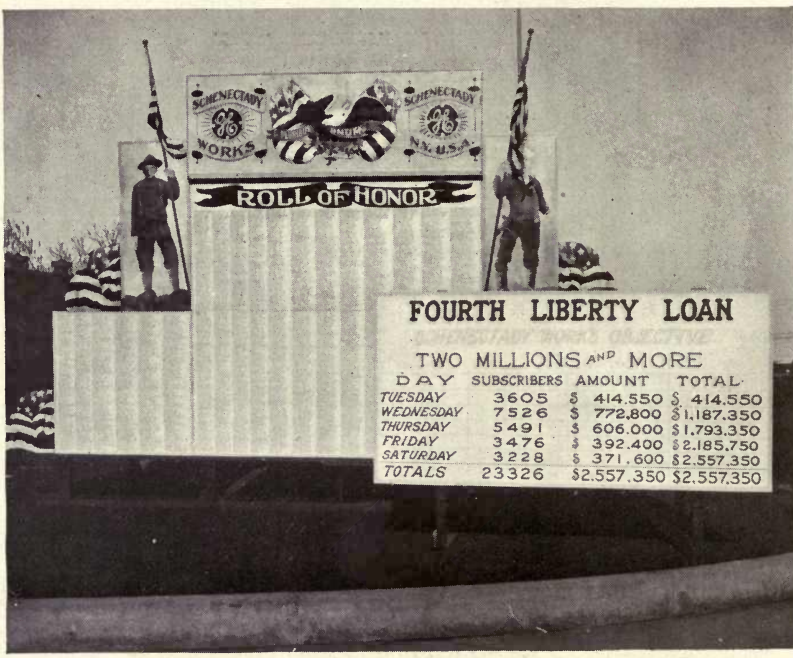
COUNTLESS FLAGS.

As I got down to building No. 6, there were dozens of flags flying, no doubt some of them removed from the inside of the various buildings—service flags, as well as the stars and stripes. Rapidly the crowd was becoming dense and I saw G. E. Emmons

The world famous artist, James Montgomery Flagg drew this poster in the early Fall of 1918 and titled it, "Together We Win." The author took the liberty of changing the title to, "Together We Won." This is an artistic presentation of the thoughts of Schenectady workers when the big whistle blew announcing the signing of the armistice.

leading a procession, followed by a dozen or more young men carrying a beautiful flag, perhaps 20 by 30 feet in size.

Instantly everybody took the cue, and the word was passed down the line that the war was over and that the lid was off! Words cannot describe the picture. They did not stop for their hats. Somebody had gotten hold of a drum and someone else



The Schenectady Works erected this roll of honor in appreciation of the 2,832 men from the Schenectady Works who entered the service.

As shown in the picture the fourth Liberty Loan subscriptions were $2,557,350.

The Liberty Loan record of the Schenectady Works totals the vast sum of nearly seven million dollars for the first four loans.

a cow-bell. Climbing on one of the big freight locomotives added perspective to the picture and made me determine to climb to some high elevation so as to get an adequate conception of the epoch-making and historic event.

Arriving at the seventh floor, I could look down the avenue—a mile or more—and still on and on they came, the great throng,

23,000 strong. There were Italian, British, French, Belgian and service flags; Liberty bond posters; flags that were old and flags that were new; and whether they were of cotton or of silk, they all added brilliance to the scene.

It seemed that automatically every motor truck in the works and every private automobile as well, had been commandeered to add to the procession. On one motor truck I counted 53 men and girls. Oh, if the G. E. band were only here! From the other window I could see this spontaneous procession surging out of the main gate and winding along half a mile to the city to help celebrate the arrival of peace and victory. It is doubtful if the people at home have heard the news. As the whistle roared, one man said, "I hope they tie the whistle down till the string rots."

Now the whistles of the city are starting in. It is like a score of election nights concentrated in one great hour. It is the maddest Mardi Gras that Schenectady has ever seen and perhaps ever will see in the years to come. But instinctively the crowd organized itself, as is the habit of well disciplined people in times of emergency. It was a mob and yet not a mob, for it moved systematically and consistently toward the city. It was a peaceful riot—it was the wild joy in their hearts that spontaneously created the "charge of the 23,000."

Do you know what 23,000 means? Did you know that scores of automobiles found it physically impossible to enter the gate because of the never-ending stream of paraders that fairly gushed out? Some of the motorists caught the spirit of the hour, turned around as best they could and joined in the procession; and it was no unusual sight to see 20 or 30 men and girls in overalls waving flags from a seven passenger touring car.

And then I thought what it all means—the lives that were saved, the suffering it will prevent and the joy that it brings to millions of homes in practically every quarter of the globe.

In our revolutionary war there was fired "the shot that was heard around the world"; but the sound of this whistle meant even more. I am sitting in the office of a man whose son's life will be spared by the blowing of that whistle. At my elbow is a young woman whose husband and brother are coming back to her—the whistle has so promised her—and another girl blushingly acknowledged that her sweetheart is in France; and tears came

to her eyes at the sweet music that prophesies his early return to her side. And one girl fainted—not from any physical exertion, not from the excitement which results from mingling in a great crowd, but from emotion while sitting in one of the buildings watching the throng below. She literally fainted with joy.

And now the railroad locomotives take up the song. The Delaware and Hudson to the left of me and the New York Central behind me—freight, passenger and switching locomotives, all of them screaming victory and peace. One passenger express train roared through the city, announcing its approach with a crescendo in a rising key and telling its departure with a diminuendo in a descending key as it shrieked on. And I doubt very much if any sound since the world began has given as much joy to as many people as the scream of these whistles.

In less than an hour the factory was literally evacuated and as I look around the offices are empty—the halls are clear—the streets inside the works are without vehicles or people.

But leaving aside joy and sentiment, leaving aside the suffering and tortures of war which have been spared to those at the front, there remain what are greater than all—militarism will cease henceforth, liberty will reign forever, subject peoples have been freed, the world is now safe for democracy.

And so, the historic message was flashed by the great steam whistle that memorable day of November, 1918.

FRAGMENTS

HOW DR. STEINMETZ WRITES

SCHENECTADY ELECTRICAL WIZARD CAN WRITE AS FAST AS HE THINKS—USES OWN PRIVATE SYSTEM—SAYS EVERY COLLEGE STUDENT SHOULD LEARN SOME ACCURATE METHOD TO FOLLOW LECTURES.

Can you write as fast as you can think? If you cannot, then your efficiency is impaired; and the difficulty of putting down your thoughts at the proper speed constitutes a "neck in the bottle" that restricts your energies.

This is like the New York Broadway subway with four tracks that can handle several hundred cars an hour, but the crossover at Ninety-sixth street station can pass only approximately eighty per cent of that number; hence, that "neck in the bottle" limits the carrying capacity of the entire subway.

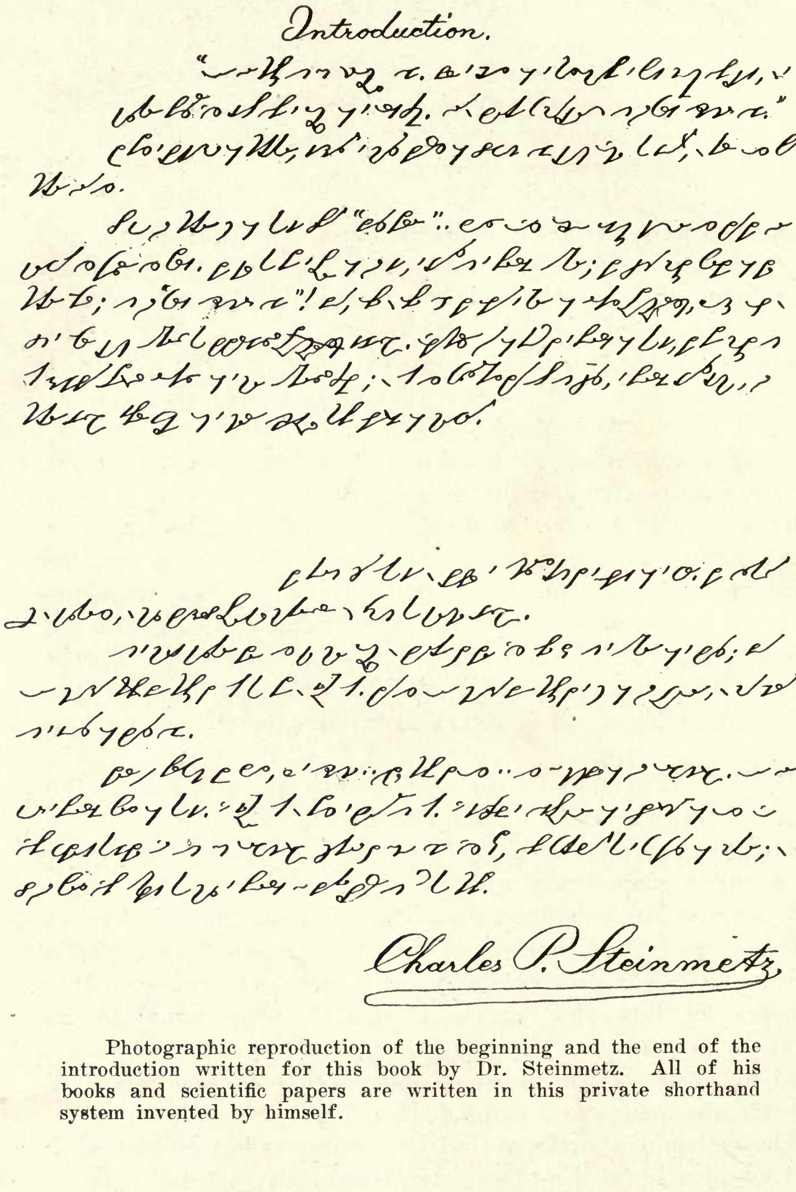
Dr. Steinmetz, one of the greatest authorities on matters electrical, and an author of many volumes useful to the scientific world, possesses no "neck in the bottle," when it comes to jotting down the results of his researches in his wonderful laboratory at Schenectady. All of his writing is done in shorthand; that is, this shorthand is the medium between his mind and the typewriter and printing press. In a recent interview upon this subject, he said:

"With this shorthand I can write as fast as I can think. The only other way in which I could put down my thoughts as fast as I could think, would be to dictate to a phonograph, but I have not always a phonograph with me.

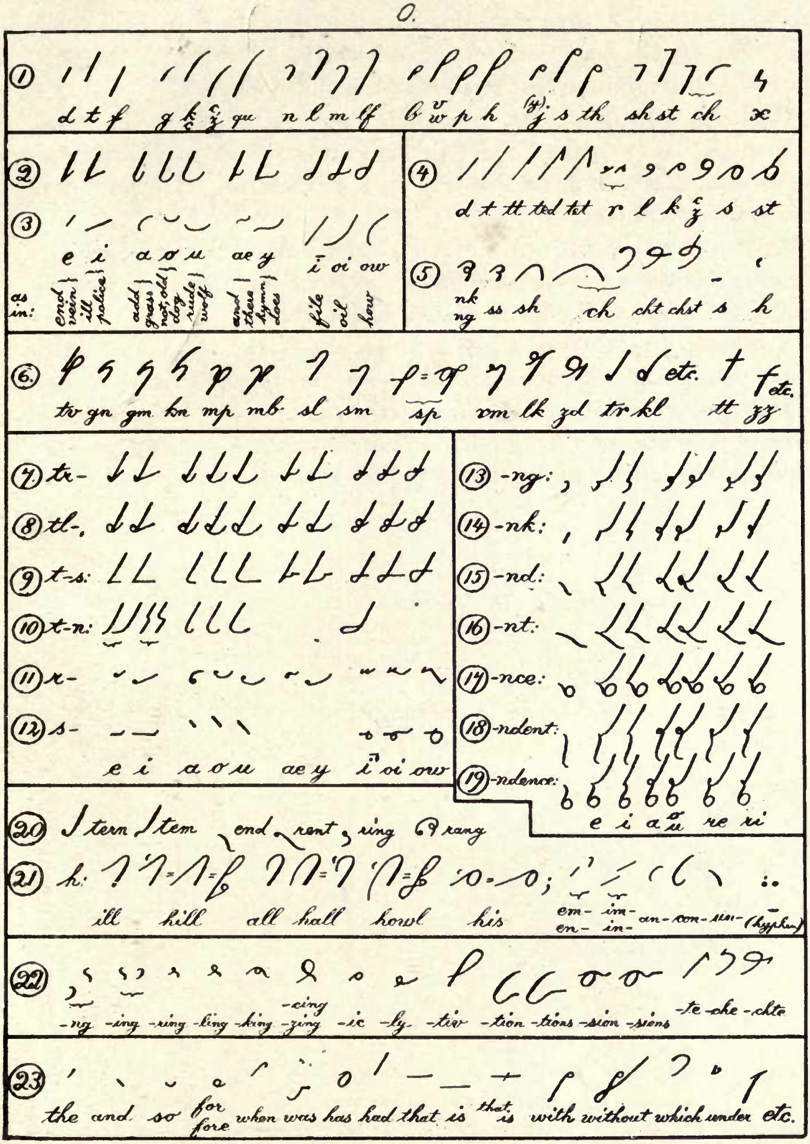
"I learned this shorthand while I was in high school in Europe, and while in college took all of my notes in shorthand. All of these notes I have preserved and had bound, and I can read them as well after thirty-five years as I could after thirty-five minutes.

"It is my opinion that every student should learn some good accurate system of shorthand so that he can follow the lectures and make notes without effort."

The system of shorthand that Dr. Steinmetz has evolved as the best adapted for writing on electrical subjects, is based upon the



Photographic reproduction of the beginning and the end of the introduction written for this book by Dr. Steinmetz. All of his books and scientific papers are written in this private shorthand system invented by himself.



The Alphabet of Dr. Steinmetz's private system of shorthand together with some shortcuts — all devised by himself. All of his literary scientific works are written in this shorthand.

"Arends" system of stenography as taught in Europe. Words are written as they are pronounced without regard to their spelling; that is, they are written phonetically. The word "height" is written h-i-t, but in this case the long "i" is used.

With his own hand, Dr. Steinmetz has written down the rules, or it might be said, the "code" of his system, so as to assist those persons with whom he is working in a translation of his reports and various articles.

With a view of affording every reader some knowledge of Dr. Steinmetz' system, a reproduction is given of the alphabet, written out by the famous electrical wizard himself.

A second illustration is given which shows the start and finish of Dr. Steinmetz' introduction at the beginning of this book and how it looked when written originally by him in his shorthand. The space required for the shorthand is but approximately one-third of the introduction when typed with double spaced lines.

ONE YEAR MEANS 8.4 YEARS AT G. E.

If you were to visit the employment department of the General Electric Company and would talk to every man, woman and child immediately after they had been engaged, you could tell them this:

"If you work one year in the General Electric factory or offices, it is almost certain that you will live in Schenectady for 7.4 years longer without quitting your job."

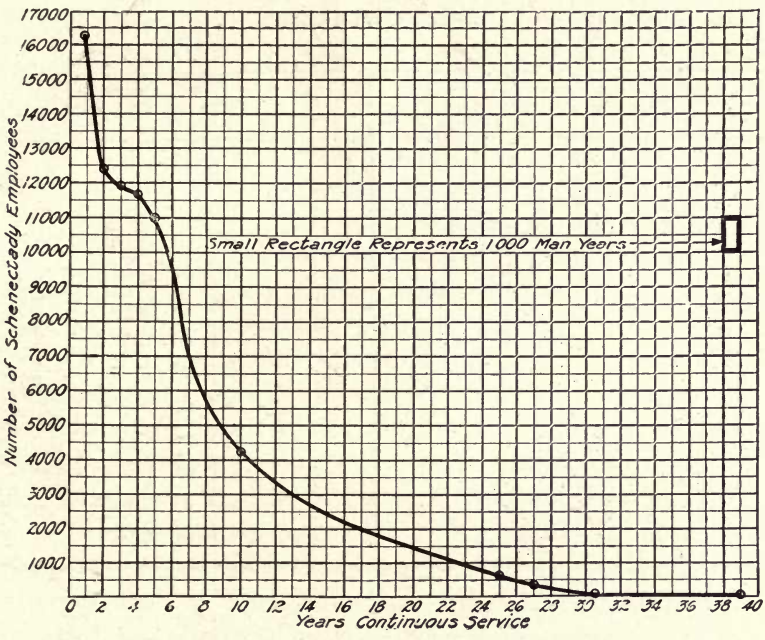


Fig. Service Record, Schenectady Works.

This curious fact is the result of a study of the General Electric Company's record of the number of employes who have worked continuously between one and 39 years. But the discovery of this fact was the result of clever mathematics. R. C. McComb, who is in the calculating room of the testing department, read about the continuous service of General electric employes which appeared in the Works News. After plotting the

curve shown above, he was able to demonstrate this fact that had never been known before:

That when the average employe finishes one solid year's work with the company, he or she will work a total of 8.4 years.

A mathematical calculation such as this is different from mere statistical work, because it was not necessary for Mr. McComb to use the figures given below after he had once drawn the curve on a piece of paper. The 8.4 years was calculated by a mathematical machine, called a planimeter, which measured the area under the curve.

STEADY WORKERS

No. of Employes.	Years of Service.
1	39
3	38 or more
8	37 or more
9	36 or more
14	35 or more
21	34 or more
26	33 or more
314	29 or more
632	26 or more
660	25 or more
4,309	10 or more
11,102	5 or more

FISHING IS DANGEROUS!

COMPARISON WITH UNITED STATES DEPARTMENT OF LABOR'S REPORT SHOWS FISHING IS THIRTY TIMES AS DANGEROUS AS WORK IN SCHENECTADY.

A man who fishes for a living is really in a very dangerous occupation, as on the average three men out of 1,000 lose their lives at this work every year. Comparing this with the figures of the General Electric fatalities at the bottom of the table, it is seen in round numbers that it is 30 times more dangerous to fish for a living than to work in the General Electric shops, surrounded by high pressure steam, high voltage electricity, with tons of steel and cast iron being swung over your head by the electric cranes, and with tens of thousands of tons of freight moved daily on the two railway systems within the works.

An examination of the United States department of labor's bulletin No. 157 on industrial accident statistics, is of intense interest to everyone who is concerned with the subject of preventing accidents. The table is reproduced below showing the number of employes in the different industries, the number of fatal accidents in 1913, and the rate a 1,000:

This table shows the hazards that exist for men who work in quarries, in the lumber camps up north, those who construct buildings, those who drive teams of horses, the employes of street railway systems, even watchmen, patrolmen and firemen and telephone and telegraph linemen are included in this survey.

Who would ever imagine that men engaged in agricultural pursuits, the farmers, should suffer from a high rate of "industrial accident?"

The last two items dealing with the fatal accidents in the General Electric works at Schenectady were added by the writer of this article in order to afford a comparison between other industries and the Schenectady works.

Industry Group Males—	No. of Employes	Fatal Industrial Accidents	Rate Per 1,000
Metal mining	170,000	680	4.00
Coal mining	750,000	2,625	3.50
Fisheries	150,000	450	3.00
Navigation	150,000	450	3.00
Railroad employes	1,750,000	4,200	2.40
Electricians (light and power)	68,000	153	2.25
Navy and Marine Corps	62,000	115	1.85
Quarrying	150,000	255	1.70
Lumber industry	531,000	797	1.50
Soldiers, United States Army	73,000	109	1.49
Building and construction	1,500,000	1,875	1.25
Draymen, eamsters, etc.	686,000	686	1.00
Street railway employes	320,000	320	1.00
Watchmen, policemen, firemen	200,000	150	.75
Telephone and telegraph (including linemen)	245,000	123	.50
Agricultural pursuits, (Including forestry and animal husbandry)	12,000,000	4,200	.35
Manufacturing (general)	7,277,000	1,819	.25
All other occupied males	4,678,000	3,508	.75
All occupied males	30,760,000	22,515	.73
All occupied females	7,200,000	540	.075
General Electric Company, Schenectady works in 1916	20,985	2	.099
General Electric Company Schenectady works' average for 10 years			.136

The first line in the above table shows four out of every 1,000 lose their lives every year in metal mining work. Experts on the subject say that this is largely due to the fact that metal mines are more likely to have cave-ins than coal mines. Thus, strange as it may seem, the coal mine with only three and one-

half accidental deaths a 1,000 a year, is safer than metal mining. This is despite the fact that the deadly fire, damp and other explosive and asphyxiating gases of a coal mine must be overcome as well as the danger of caveins.

Navigation, the fourth item in the above table, shows the same loss of life as does fishing. Railroad employees come next—two and four-tenths men a 1,000, while electricians for light and power show an average of two and a quarter deaths a 1,000.

THE COMMITTEE OF ONE THOUSAND.
This Committee sold $8,791,250 of Liberty Bonds, and collected $339,313 in Donations for War Work.

THE COMMITTEE OF ONE THOUSAND

It is fitting that the last chapter of this book should give credit and tribute to the Committee of One Thousand which raised the millions of dollars in the Schenectady Works for Liberty Bonds, Red Cross, Y. M. C. A., Salvation Army, Knights of Columbus and the other war funds shown in the illustration of the " Schenectady Works War Record."

The following letter from the Liberty Loan Committee of the Second Federal Reserve District, is worthy of preservation:

April 14, 1919.

General Electric Company,
Schenectady,
New York.

Gentlemen:

The Liberty Loan Committee desires to express to you their appreciation of the assistance you have given us in submitting the plans developed by your Committee of One Thousand, for handling the subscriptions of the various Loans. It may be of interest to you to know that this plan has been adopted by us as the most complete system developed in any plant. It has been incorporated in our plan book. practically in its entirety.

I feel that the study which you have given to the preparation of this plan and its execution, has been most beneficial in arousing the patriotic spirit of employees in industrial plants throughout our district and that much of the success of the forthcoming Loan will be due to the wonderful example set in previous Loans by the employees of the General Electric Company.

Very truly yours,

GILBERT B. BOGART,
Assistant Director of Sales.

The following are the names of the Committee of One Thousand:

SCHENECTADY WORKS.

General Chairman, G. E. Emmons

Executive Committee

H. L. Baltozer
J. S. Conover
F. H. Gale
G. H. Putman
A. L. Rohrer
E. G. Waters
S. L. Whitestone
A. W. Clark

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M. C. Jones, Deputy

Miss A. M. Eddy
G. C. Hollister
B. B. Hull
W. F. Shafer
W. A. Mower
Mrs. Morgan
C. W. Mochrie
G. L. Kannofsky
G. McK. Roberts
J. Scott Thornton
F. W. Baumgrass
M. O. Williams
D. R. White
E. G. Hall

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C. A. Jagger
G. L. Schermerhorn
H. C. Pease
F. I. Degen
H. C. Senior
H. R. Sargent
A. F. Batchelder
J. L. Hall
H. H. Mapelsden
H. A. Laycock
M. A. Atuesta

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H. M. Parker, Deputy

N. J. Kingsbury
H. M. Parker
H. L. Erlicher
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B. H. Norris
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J. S. Apperson
C. P. Turner
J. L. R. Hayden
C. M. Ripley
L. DeW. Efner
W. J. Reagles
J. H. Friedman
J. S. Oppenheim
C. M. Rhoades

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J. G. Barry
E. P. Waller
J. V. Wallace

T. A. McLoughlin, Deputy

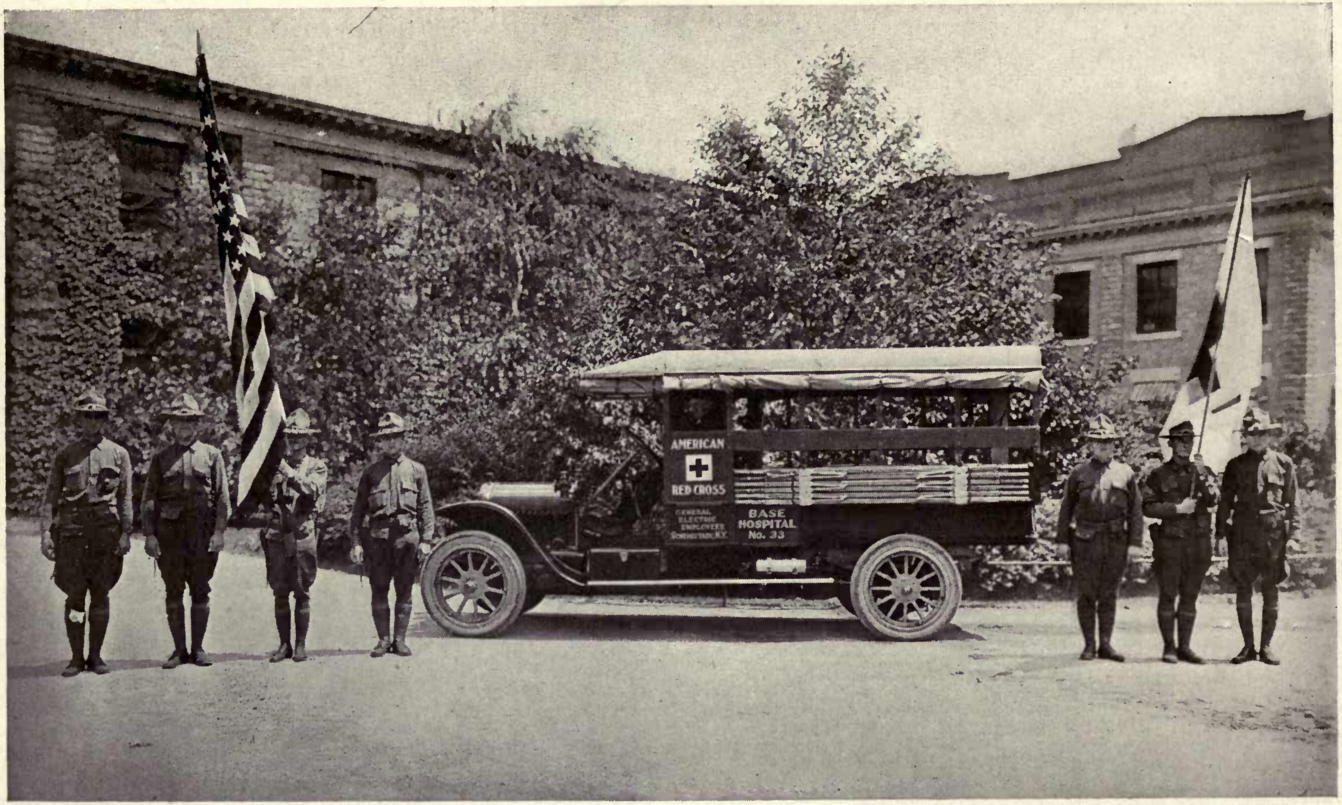
D. R. Bullen
A. M. Jackson
F. G. Vaughn
N. R. Birge
R. E. Brizee
W. G. Carey
W. S. Clark
J. C. Dallam
R. H. Carlton
E. E. Gilbert
R. B. Beale
R. S. Johnson
J. W. Upp
A. B. Lawrence

War Service Record of the Schenectady Works. Note Service Flags, Liberty Bond purchases and donations.

SECTION A

T. E. Drohan, Superintendent

T. E. Drohan
E. M. Hewlett
F. W. Paterson
A. B. Lawrence
S. W. Mauger
F. J. Yendley
D. S. Morgan
C. H. Hill
W. J. Green
C. R. Storm
H. D. Holbrook
C. T. DeFriest
H. H. Gardiner
E. Hallenbeck
P. J. Whitmore
C. J. Dion
H. E. Starbuck
H. L. Smith
C. DeH. Brower
W. F. Sneed
E. Weber
E. H. Beckert
P. G. Langley
R. B. Johnson
R. M. Spurck
G. H. Tovey
F. W. Mussina
E. Bern
E. I. Snyder
A. E. Bailey
G. W. Strobel
W. B. Connolly
E. S. Jordan
B. Troischt
A. G. Bancroft
W. H. Gallant
P. Rheom
R. M. Campbell
P. Hooley
John Preo
W. L. Magee
J. Akin
W. Johnson
F. Yearsley
R. Conklin
E. A. Rogers
R. Moore
N. J. McMahon
C. B. Lacey
Wm. Purcell
Mrs. M. Marx
Harry Bourgeois
F. F. Schwentker
A. Rainert
H. S. Edgerly
C. F. Shannon
A. W. Greer
H. B. Wilson
L. W. Smith
J. F. Freese
J. H. Grudgings
E. A. Cummings
F. J. Yendley
G. P. Bliss
B. C. Perry
J. H. Miller
S. T. Cole
H. O. Kemp
A. McQuade
M. Weatherwax
C. B. McDonnough
F. Haverly
H. C. Kemp
F. A. Kelly
T. Seymour
J. McNearney
Miss H. Seeley
Miss M. Cheedzeitski
F. E. Willard
G. Lange
E. Roberts
J. J. Farrell
R. J. Rector
E. Harrison
A. M. Peek
L. M. Warwick
C. E. Jones
H. Van Patten
D. Edwards
W. J. Beck



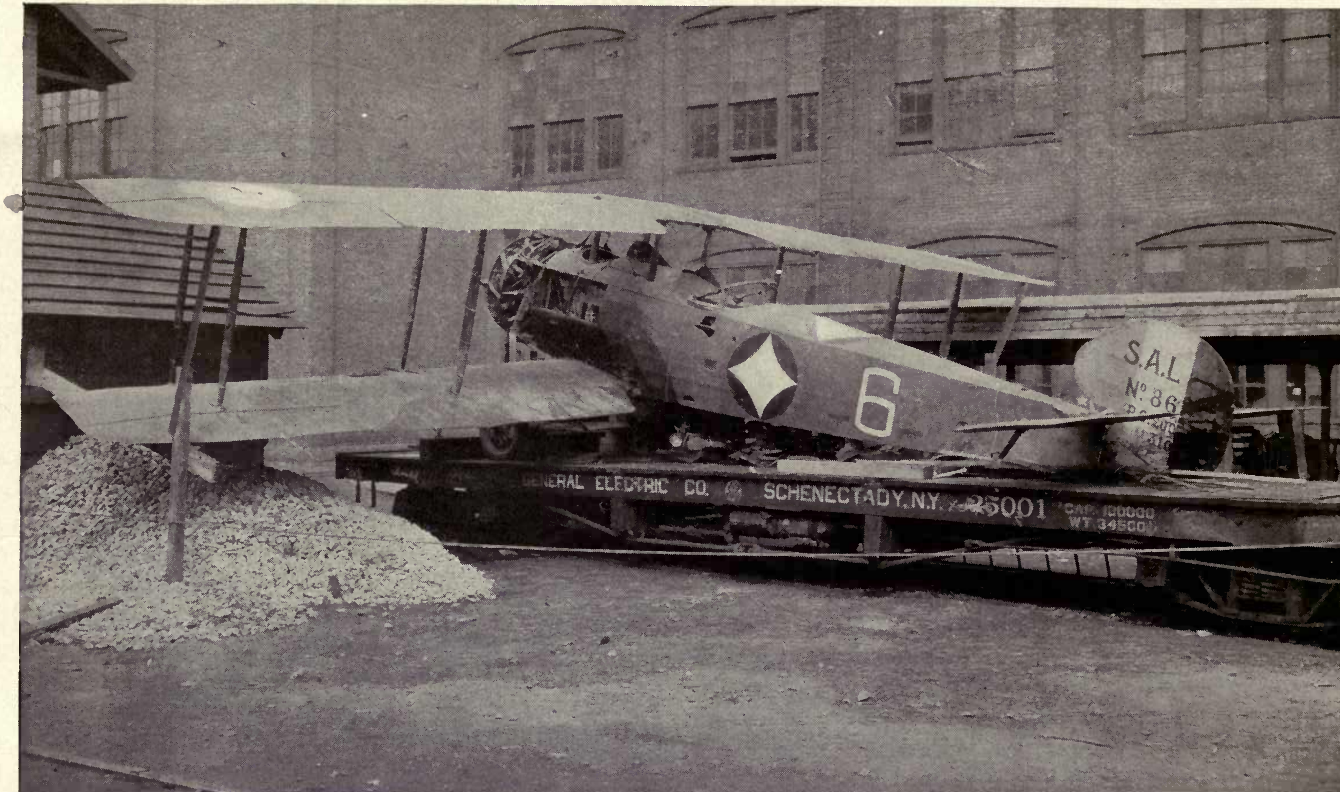
The Red Cross ambulance purchased by contributions from employees of the Schenectady Works. This was presented to Base Hospital No. 33 of the American Red Cross.

W. Gaiger
Miss M. Grace
E. Griffiths
B. Lovine
R. W. Brown
A. Bruno
H. A. Crary
F. R. Pitcher
W. S. Murphy
F. Morhoff
F. Spoonnoggle
C. P. Bloomer
F. Dowcett
R. Dawson
L. Altvater
W. Lounsbury
J. Devine
Mrs. A. Wilson
C. P. Bloomer
B. C. Waite, Jr.
A. Flowers
Miss L. Dawson
D. Miller
D. Simpson
F. Lange
W. Glass
H. Hamilton
E. O. Jones
H. D. Holbrook
John Clute
G. A. Elder

SECTION B

J. F. Madgett, Superintendent **R. B. Wands, Deputy**

Miss R. C. Fenzl
Mrs. G. W. McDonald
W. E. Edwards
J. Bedard
F. Van Schaik
B. C. Waite
A. Turner
F. Cook
J. Hamblet
A. Connelly
C. Salmonsen
W. Perran
W. Alberts
R. J. Cody
F. T. Brown
B. Ford
L. Ginsburg
F. Kelley
A. J. Wagner
L. Reynolds
H. Stearn
S. Bishop
P. Wayand
B. Wintle
P. Lathrop
M. Smith
A. McClellan
M. Drums
C. Trice
C. Trawbridge
G. Bowers
S. Hurzog
J. Proper
G. Yager
F. Metcalf
C. DeMarco
F. Reed
W. H. Todd
G. Rynex
A. Yorkston
H. Gould
P. Tucker
W. Sunderland
H. McPartlon
A. Voline
D. Bergen
C. H. Franklin
A. F. Baxter
J. G. Hisert
M. Van Patten
A. Wolcott
C. H. Kanzelmyer
C. E. Scott
B. McMeans
R. Kearney



A French aeroplane on exhibition at the Schenectady Works during one of the Liberty Loan Campaigns. This was inspected by thousands of workers.

SECTION C

S. S. Forster, Superintendent **J. Bentley, Deputy**

G. G. Maier
J. Van Schoick
L. Flannigan
J. Allen
W. Sargent
R. Hendry
R. Campbell
J. Wooten
R. Graham
J. Mohan
J. Williams
R. Smith

N. Armstrong
C. Mead
C. B. Stevens
O. W. Hupp
S. Houston
Miss C. B. Gould
B. Albright
W. Hamell
A. Neuber
W. Hogan
W. Gould

SECTION D

C. W. Marcley, Superintendent

H. S. Dillenbeck, Chairman **Mrs. I. G. Jones, Secretary**

J. D. McHugh
H. Droms
Wm. McLaughlin
W. Stairs
G. Peek
A. Hinsey
Miss Vincent
A. Ashdown
P. Elliott
B. Baldwin
C. Schoonmaker
B. Lindner
C. P. Husted
B. McKee
L. Hagadorn

Miss Strause
W. Mathias
Mrs. Brown
Miss Van Patten
Miss Hugo
Miss Kehrer
C. Shaw
H. Waters
Wm. Kelly
C. H. Kaler
E. E. Wentworth
D. Pangburn
C. Harford
W. Sebast
E. Steen

SECTION E

H. Farquhar, Superintendent

H. Fradenburgh, Secretary **G. Rowbotham**

Foremen's Sections

Turbine Department

Wm. Madigan, General Dept., Chairman

Geo. Wintle
W. B. Harris
M. Murphy

W. Brady
H. Cotton
A. Bufe

A Patriotic Mass Meeting in one of the Galleries of Building No. 60. The Contactor-Control Department thus dedicated its Seventy-five Star Service Flag with appropriate ceremonies.

F. Cary
Wm. Herron
F. D. Loucks
L. Wagner
W. Clark
H. Lens
D. Maynard
T. Hawley
H. Ward
E. Tinney
R. Kilgallen
R. Wintle
S. Daniels
C. Strohmeier
S. Schultz
W. Veeder
T. Keating
I. C. Bullock
P. Carroll
G. Dewey
E. Sheehan
S. Dzikowski
C. Rynex
J. Jankowski
P. Cunningham
A. Huffmire
E. Barnard
R. Glennon
J. McGuire
W. Brigg
J. H. Starbard
J. Blackburn
F. A. Disbrow
J. Short
Miss E. Thayer
E. Barlow
W. Dollard
R. Mattocks
G. Rae
P. Mulvey
W. Rost
E. Burke
C. Weh
E. Weiss
E. Dillon
F. Smith
Miss E. Spencer
A. G. Weber
H. Forte
W. H. Schryver
W. Van Volkenburg
Miss C. Dente
W. Bridges
C. Arrude
A. Lattanzio

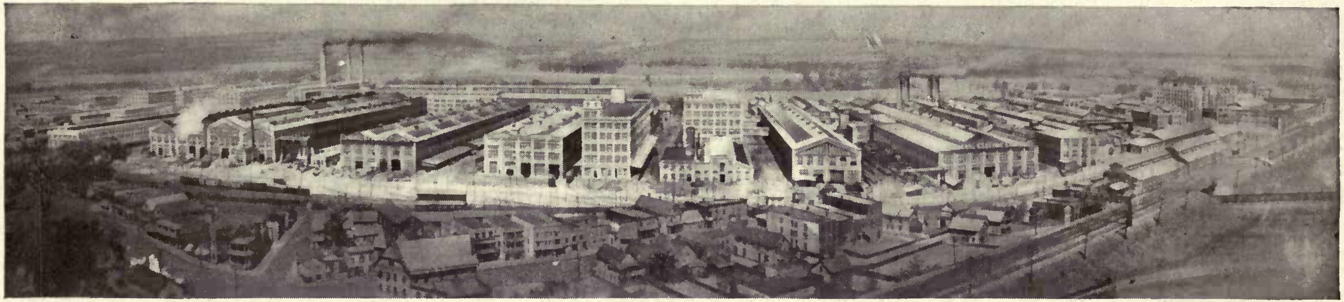
Night Force

V. Turnbull
C. C. Ward
Wm. Hornbeck
G. H. Farmilo
F. W. Lubking
T. Hallinan
J. F. Ryan
J. Sauter
F. A. Lamoeraux
H. Bouillett

Turbine Department

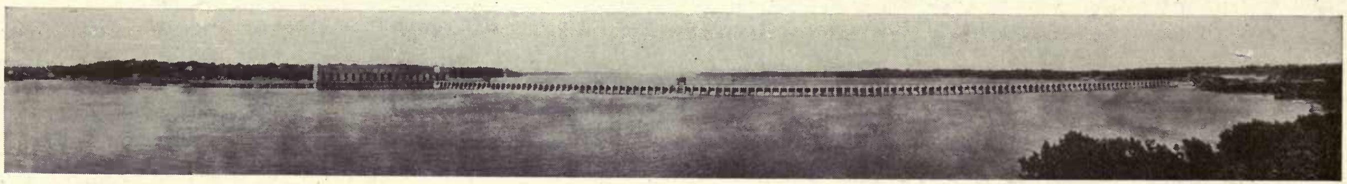
C. Palmer, General Dept. Chairman

M. Toohey
P. McGarr
D. Dute le
A. Montone
B. Hesner
W. Boink
J. Fl'nn
B. Walker



Panorama — Photograph of the Schenectady Works.

The Mohawk River is in the background, the New York Central tracks on the right and the Delaware and Hudson tracks on the left.



Panorama of the big hydro-electric plant and dam at Keokuk. Present capacity 150,000 KW. Ultimate capacity 300,000 KW.

A. Blesser
R. M. Downson
H. I. Magill
D. Queeney
P. Walliman
H. W. Gould
E. D. Bloodgood
T. P. Enright
J. F. Moran
E. P. Rahn

SECTION G

E. Murday, Superintendent

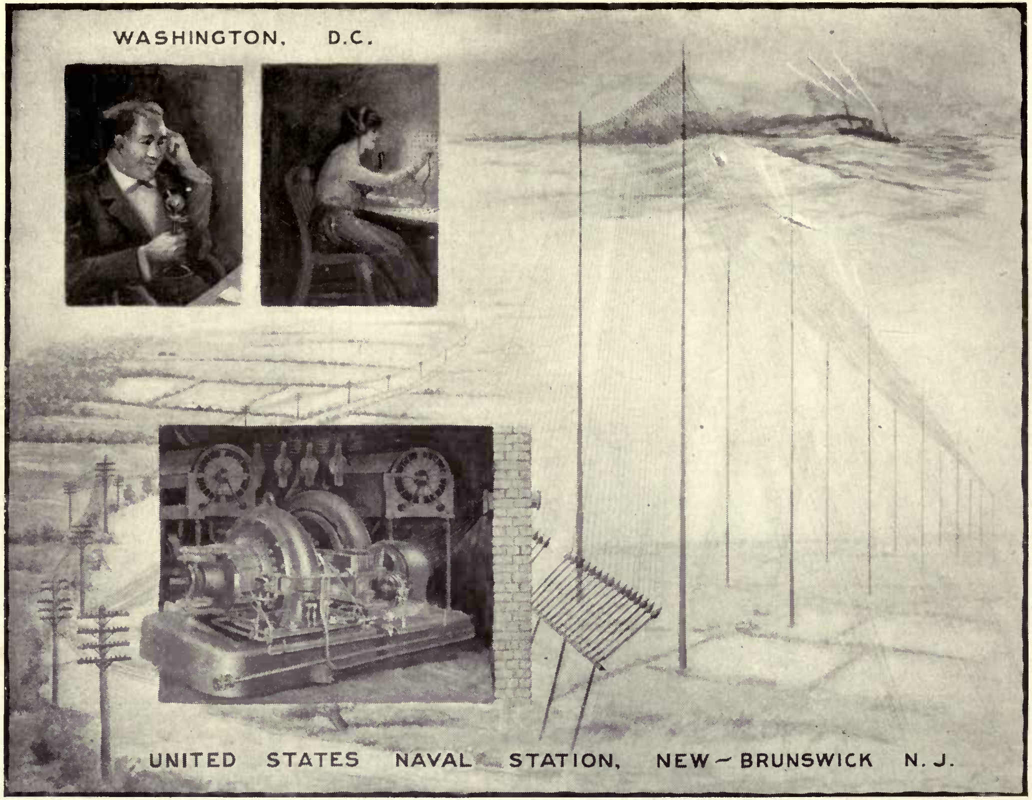
C. W. Hardy
W. C. Willsey
Miss S. Christiance

Contractor Control Department

C. A. Rhein
C. A. Voight
R. Allen
Englehardt
J. Williams
R Dellapenta
J. Eddy
O'Dell
W. Coughlin
F. Wright
H. Hall
R. McCormick
C. Millington
Hallenbeck
W. Bilting
Ladue
J. Biggerstaff
C. Haarde
C. Hauss
Howenstein
J. Cole
C. Lenshan
A. L. Fredericks
G. Crawford
K. Beck
F. Simmons
H. Miller
Leddick
Miss Campbell
Miss Burke
P. Cammarato
Mrs. L. Marsh
Bagnall

Controller Department

John Diehl
H. Gauss
J. Amsler
M. Clune
M. Jackson
H. Wright
H. Nicolas
F. Wtodarczak
W. Blanchard
M. Metz
H. Wood
A. Barry
J. Barringer
J. Ulrich
M. Swan
T. G. Crippen
J. Lauder
G. Kruge
C. Weber
C. Sturgess
J. Holtslag
J. Babbitt
W. Fowler
M. Reedy
E. Romanoff
G. Alloway
W. Knowles



Secretary Daniels sitting at Washington used his regular telephone instrument, and his call was plugged through the regular telephone switchboard; there his voice travelled over the regular wires 180 miles to New Brunswick; and from thence his voice travelled via wireless to President Wilson on board the S. S. George Washington.

The high frequency alternator, the magnetic amplifiers, and the pliotrons which made the wonderful feat possible, were made at the Schenectady Works. The antenna wires are 400 feet above ground, or practically the height of the Equitable Building. This was drawn by Edward Finnan, Building No. 20. The New York Evening World Magazine of April 5, used part of this picture.

Searchlight Department

D. F Madden
F. R. Beckert
S. A. Nicho s
L. F. VanderVort
F. Stephens
A. Peck
Wm. Thomas
C. Emmett
A. Holt
J. L. Ducharme

Screw Machine Department

J. Wilson
A. Griffiths
A. J. Van Guysling
G. Sligo
L. J. Franzen
Geo. Rice
John Hicks
Frank Hegnier
H. F. Dunckle
G. H. Warner
J. Renkawitz

Sheet Metal Department

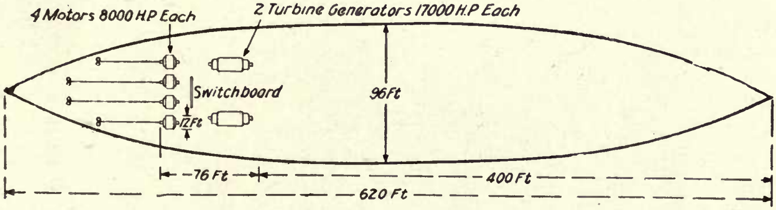
G. Wilbur
F. Hoffman
M. Wa'rath

SECTION H

F. J. Newton, Superintendent

C. J. Legere
F. Farrell
D. Maratto
Miss B. Berrigan
Geo. Feast
J. L. Gregg
H. H. Tell
A. Shepherd
Miss Edith Weast
E. E. Platto
M. Sullivan
J. Lasky
Miss C. Scholtes
Miss D. Weaver
F. D. Ruhl
I. White
E. Lemoine
Mrs. T. Canaley
Miss R. Gibbons
O. D. Haury
N. Male
W. Quay
G. Ford
E. Wilbur
Ed. O'Rourke
W. S. Brundige
J. Brown
Mrs. C. English
H. F. Gage
J. Rossi
H. Wood
J. T. Mahar
Wm. Potts
Wm. Predel
Chas. Herrick
Ed. Fitzgerald
Wm. Krisjowski
J. M. Coon
C. A. Scrafford
T. Ponzillo
C. Rach
H. Miller
Miss L. Fich
Mrs. M. Hamlin
W. W. Clark
W. G. Russ
Ed. Hayes
F. J. Newton

View from top of Building No. 2 looking down the Main Avenue of the Works. Under this street is a pipe tunnel nearly one mile long.



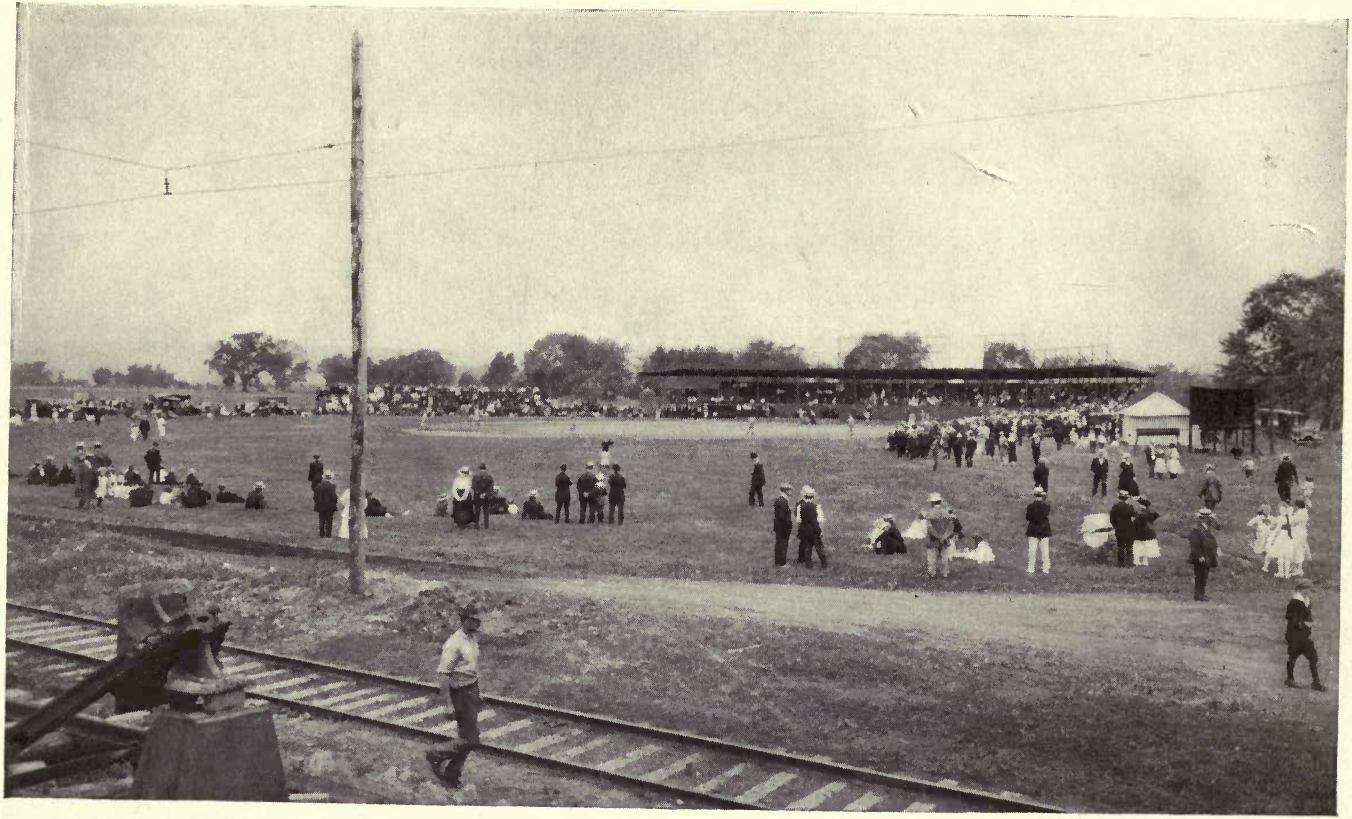
Electric Propelling Machinery
Battleship New Mexico

The wonderful feat of propelling a great battleship by electric motors was made possible by the engineering and shop facilities of the General Electric Company. This diagram shows the simplicity of electric propulsion. The motors were made in Building No. 52, the turbines in Building No. 60, the turbine generators were also largely built in Building No. 60, the controlling apparatus was constructed in Building No. 23. Mr. W. L. R. Emmet, Consulting Engineer is responsible for this radical and bold departure from old engineering principles. It required almost 10 years, against bitter opposition, for him to establish the superiority of electrical ship propulsion in marine circles.

SECTION I

G. H. Ashman, Superintendent

C. Reid
R. F. Yates
P. C. Ashley
L. G. Fradenburgh
W. R. Senigo
D. G. Norton
F. Herzog
F. Hildreth
A. W. German
E. Clowe
I. O'Leary
L. Grandy
A. R. Smith
J. Whamer
P. Circinione
J. L. Wagner
O. DeFreest
R. Richardson
L. Yoott
W. Fowler
W. Vedder
J. G. Blau
W. M. Shaw
Geo. Scidmore
J. Mason
H. Requhardt
G. W. Hagadorn
J. F. Heath
Mrs. Hubbard
Miss S. Brown
Miss A Barlow
Mrs. A. Russ
A. Slater
T. Barry
A. D Parks
G Bank
E. Johnson
G. Madadieu
W Kivlin
P. Carroll
W. R. Sullivan
J. W. Mitchell
J. Armstrong
A. Lansing
C. Pearse
Geo. Ogden
E. A. Jandro
H. McManus
C. Rogers
Wm. Smith
F. Cullen
C. Kindrich
W. Sands
A. M. Putman
H. Hardley
C. Sherman
G. Smith
J. Mason
H. Van Patten
Miss E. McCullough
Miss E. Premo
Miss K. Smith
Miss S. Jones
Miss J. Bowles
Miss J. Whitbeck
Miss F. Thornton
R. Van Huysen
B. J. Sydow
Miss Helen Grant
Geo. Scott
Wm. Snyder
Frank Kelsey
A. H. French
W. Wasson
A. Braccio
A. Bird
Geo. Barton
Miss H. Sellman
C. W. Reuter
B. W. Dingman
J. H. Hoyt
W. G. Huston
Geo. Hartman
W. Millard
C. Enos



An exciting base ball game on the athletic field. The war gardens on the left could not be included in this picture.

SECTION J

T. Moore, Superintendent

Tom Moore, General Chairman of Section **J. T. Heffernan, Secretary**

J. R. Byrne, Chairman Building No. 77

W. C. Kelly
Miss A. Brothers
James Shannon
T. Cuomo
J. Groghan
W. H. Phillips
Miss A. L. Reilley
C. Fransen
H. K. Schuyler
C. W. Geisner
H. Hall
C. Grothe
S. Vernon
W. Leonard
E. Erwson
A. Gray
F. W. Fagal
Miss N. Henneberry
Miss M. Donnelly
Miss R. Fellows
Miss A. Guliano
F. B. Ennis
Miss H. Siepman
Miss H. Cummings
Miss M. Cawley
Miss A. Stark
Miss F. DeBlasio
J. J. McMann
Bernardina Munster
Frances Fensel
Winifred Dombowski
Pauline DeMarco
Frank Dunn
H. J. Hambrook
Miss M. L. Murray
D. Hayes
J. B. Dowling
H. R. Sargent
E. Van Amberg
A. Bartlow
J. Ridley
Miss G. Swatling
A. Guiderella
F. Lagaski
J. B. Wicks
Miss J. Cunningham
E. Lavoy
Miss T. O'Brien
Miss O. D'Arcy
Miss L. McCabe
Miss A. Jackson
F. L. Spear
T. H. Grandy
Miss B. Koslowf
Tom Harris
R. Hallenbeck
B. Pettit
J. Killough
J. Hoffman
C. R. Kellogg
Miss M. Fox
Miss R. Quay
C. E. Gormley
G. Bush
Miss K. Berberick
F. Cermak
J. Riha
J. Pardi
A. Sedina
J. Konicek
J. Vazal
W. Friedman
J. Cervenka
Miss J. Hildebrand
C. Hardil
J. Caruso
S. Pietrowski
M. Davis
F. Kanzelmyer
L. W. Topping
A. Maynard
E. Johnson
J. Winkler
F. Patterson

S. E. Ford
E. S. Feinger
F. A. Ritton
J. Torki
E. Pearse
S. DeMassi
J. Oliski
J. Meade

TESTING DEPARTMENT

J. D. Harnden
F. L. Kemp
T. H. Tate
R. R. Miller
P. M. Gillilan
R. Schaeffer
C. L. Talford
I. A. Uhr
G. M. Reed
L. J. Dunlap
F. L. Reed
W. E. Saupe
R. G. Davis
D. A. Ennis
C. N. Hutchinson
H. E. Richardson

GROUNDS AND BUILDINGS DEPARTMENT

C. G. Hulth
J. H. Halsey
F. E. Bedell
A. W. McAllister
I. Lang
H. A. Hagadorn
W. B. Clark
C. H. Brewer

SHIPPING DEPARTMENT

M. C. Fitzgerald
W. S. Knight
A. E. Moody
W. H. Vrooman
N. J. McMahon
Mrs. Marks
Harry Bourgeois
Wm. Purcell
G. B. Lacey
J. C. Palmer
H. E. Mead
J. H. Snyder
Chas. Newell
John Garrie
William O'Brien
P. F. O'Neill
J. Dorn
E. McKelvey
John Cooley
J. C. McNamara
John F. Benzie
W. L. Galbraith
S. J. Woodward
M. K. Phillips
Edward Venditti

APPRENTICE DEPARTMENT

C. F. Marquis
H. Ambrose
M. Snyder
C. E. Dorland
E. Lelman
Edith Ennis
S. M. Bigwood

NIGHT FORCE

S. M. Kennedy
R. E. Doherty
John Martin
R. C. Powell
N. Armstrong
E. Albright
John Winnie
Frank Tebo
John G. Blare
B. Iovius

A soon-to-be-forgotten view of the old Erie Canal looking from State Street toward the General Electric Works. This picture will be of historical interest before many years have passed, as it is now being replaced with the new boulevard which will be practically one hundred and fifty feet in width.

G. Hughs
J. L. Ducharmer
H. O. Requardt
E. Wolf
L. Corrie
Geo. First
P. Bonville
John Turke
Mr. Sawerson
Mr. Weber

Accounting Department

H. L. Baltozer
C. J. Turnbull
F. J. Visscher
G. S. Spaulding
D. C. Campbell

Blacksmith Shop

J. A. Van Laak
Mary Layden
Lillian Newton
J. Richards
J. Rusoig
W. Devlyca

Boiler Shop

R. E. Howe

Brass Foundry

Wm. Slatterly
P. Denham
T. Wieblesky
J. Lynch

Central Tool Stock

G. C. Reilley
A. F. Boughton

Cost Department

M. F. Simmons
E. P. Higgs
W. H. Leilhim
J. M. Howell
J. Kestner
L. Smith
H. Clay
M. Rix
J. Harbison
J. Freese
R. C. B. Chase
F. L. Spear
F. Sharbach

Crane and Elevator Repair Department

J. Giles
B. Cawley
T. F. Noonan
H. McDougall
J. Coughlin
J. Reynolds
R. Hall
J. Enright
C. White
T. Buckley
P. Baumler

Drafting Department

J. E. Yorkston
A. J. Haight
C. A. Wadsworth
A. G. Lincoln
J. J. Casby
J. E. Glen
J. Kilfoyle
W. Tryon
T. C. Stone
E. Anderson
G. Streebel
A. E. Bailey
E. I. Snyder
C. Fischer
A. G. Elmendor
C. Taylor
H. S. Snyder

Fire Station

F. J. O'Connor

Flow Meter and Regulator

H. Lord
F. Martin
H. Van Woert
W. Hastings
J. Herrick
L. Sheldon

Garage

Geo. Weller

Hospital

G. Rowlands

Industrial Heating

B. G. Tang
W. S. Mattocks
Sam Jacobs

Industrial Service

E. B. Merriam

Inspection

W. H. Haines
E. Mansfield
C. Connell
F. Phillips
H. Houghtaling

Insulation Laboratory

L. E. Barringer

Landscape Gardening

R. N. Ramsey

Medical

Dr. L. E. Coates

Mica

C. F. Peterson
W. Lamboy
W. Waterfield
W. Salmonsen
D. Dittman
Francis Burlingame
Nellie McManus
Miss Satisbury
Mary Tabor

Millwright

John Miller
Wm. Cox
Sam Logan
J. Burdell
John Waldron

Phillips Ast
Howard Holt
Jas. Buller
T. J. Hall

Order and Stock

F. T. Hannan
Mrs. M. Ryan

L. L. Green
H. T. Smith

Patrol

D. McCollam

Pattern

J. C. Dancer
S. Smith
Mr. Ho t

Mr. Hisert
Mr. McBurney

Pay Roll

G. H. Putnam
A. Lundgren
A. G. Rolfe

Anna King
Laura Bigsbee

Piece Rate

Frank Hoppman
E. A. Cummings
F. J. Yendley
H. He'nbuck

Z. Z. Brockett
W. W. Grupe
C. N. Hulbert
G. Brewer

Pneumatic Tube

Geo. Briggs

Power Station

A. W. Nisbet
J. H. Fryer
N. Claflin
H. Martin
M. Brown

H. P. Moore
W. Luke
G. A. Brown
N. Malloch

Punch Press

A. K. Christie
C. S. Stock
H. R. Decker
J. Spencer
M. Rosenburg
R. Quonus
A. Annal
J. Bari

E. Slocum
S. Kotarski
J. Strader
E. Simmons
J. Cemka
F. Archiba'd
J. H. Briggs
F. Tebo

The new boulevard is being built while this book is being printed. This is a view looking from State Street toward the American Locomotive Works, with Proctors Theatre shown on the left.

L. Seeley
F. Turcwicz
D. DeMarco
F. J. Lally
Wm. McNaughton
M. Viva
W. Reynolds
J. Winne
P. J. Palock
E. Bernier
A. J. Saul
L. Huncoi

PRODUCTION DEPARTMENT

F. A. Ham
F. F. Cunningham
H. P. Blades
L. D. Wasson
M ss A. M. Brucker
H. M. L nk
W. A. Mersereau
J. A. Sullivan
L. B. Wolf
Miss Hisert
G. P. Bliss
B. C. Perry
J. H. Miller
Miss T. Cola
G. J. Goetz
H. Truax
C. B. Wilber
A. J. Stearns
E. A. Whitney
F. H. Davidson
Miss O'Keefe
J. B. Dowling
H. J. Benzie

Receiving

E. S. Beyer
J. Thompson
H. H. Hull
F. Savino
J. R. Waterman
P. Sezdrowski
J. Q. Hanrahan
H. Cardinal

Research Laboratory

Dr. W. R Whitney
L. A. Hawkins
R. W. Moore
C. Krueger
W. E. Ruder

Restaurant

F. E. Basley
G. Radliffe
M. Monks
J. Zanetti
Gammetti

Rigging

Wm. Jansen

Safeguard

C. L. York
J. F. Beehm
A. G. Hofer
F. L. Swan
M. J. Bunyan

Scrap

R. S. Emmet

Shop Electric

J. A. Clark
J. Tranter
J. Hines
E. Conklin
F. Cever

Shop Wiring

J. Sullivan
A. Lonz
O. C. Atkin

Standardizing Laboratory

L. T. Robinson
L. F. Millham
R. W. Shupp
E. C. Powell
W. R. Lunch
J. H. Reed

Steam Fitting

Geo. Cowlam
A. Quay
S. Wright
J. Smith
G. Van Worth

Stock

A. C. Guernsey
G. P. Avery
J. S. Briggs
Miss F. Gass
C. J. Reynolds
D. H. LaCrosse

Testing Laboratory

J. A. Capp
M. H. Steinmetz
Geo. Wright

Tool and Die

C. Baumgartner
A. Bowman
S. E. Davis
H. Hempel
H. Byrne
T. Miller
R. Bromley
H. Sherman

Transportation

J. H. Rosenstock
G. G. Hogan
J. J. McGovern
Ban Angelo
H. C. Kruezer
L. Hirschmann
J. F. Henry
J. C. Drumm
A. Seavull
Frank Chorso
F. A. Cardinal
Miss M. M. Nolan
F. Countryman
V. Delorenzo
F. Edelman
C. W. Hines
T. Kearney
P. Van Vorst
A. P. Pierone
H. K. Baumis
A. Hammond

Trucking

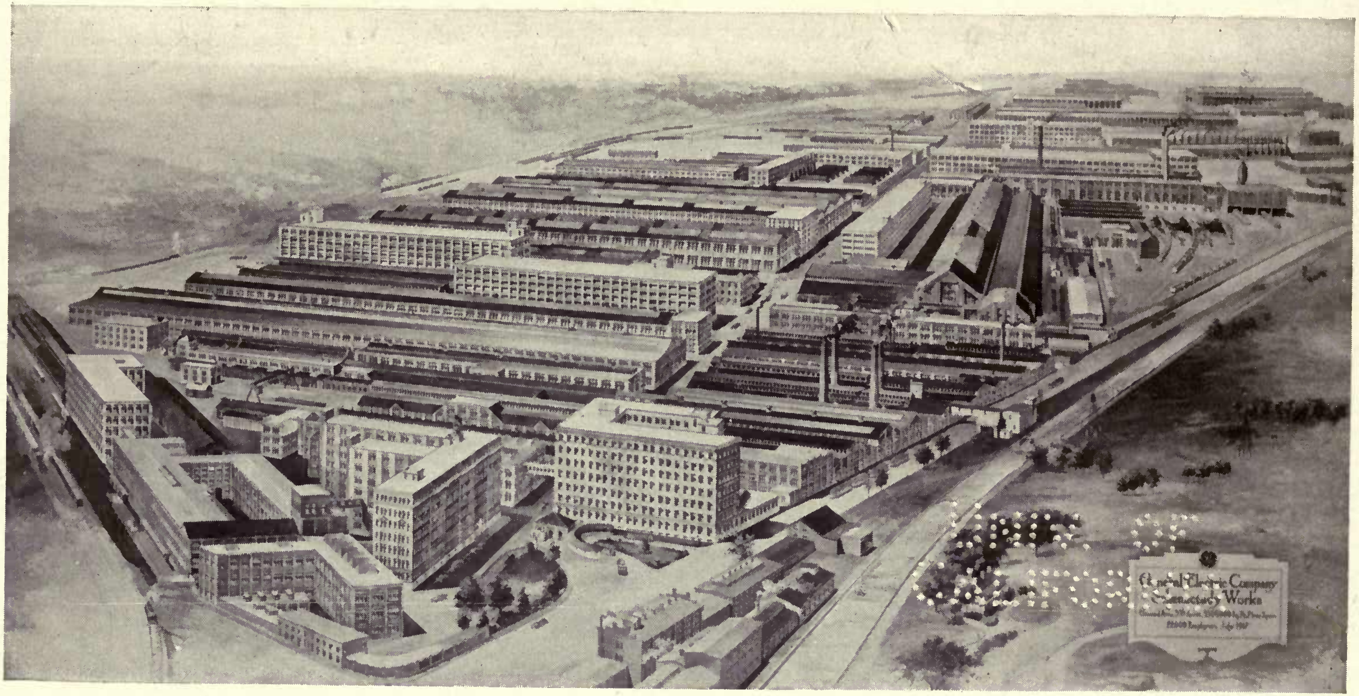
Geo. McDonald

Welfare

A. W. Clark
R. E. Rugen

X-Ray

R. C. Robinson
R. E. Winne
Lena Van Wormer



Birdseye view of the Schenectady Works as it appeared in 1918. There are over two hundred buildings in this group.